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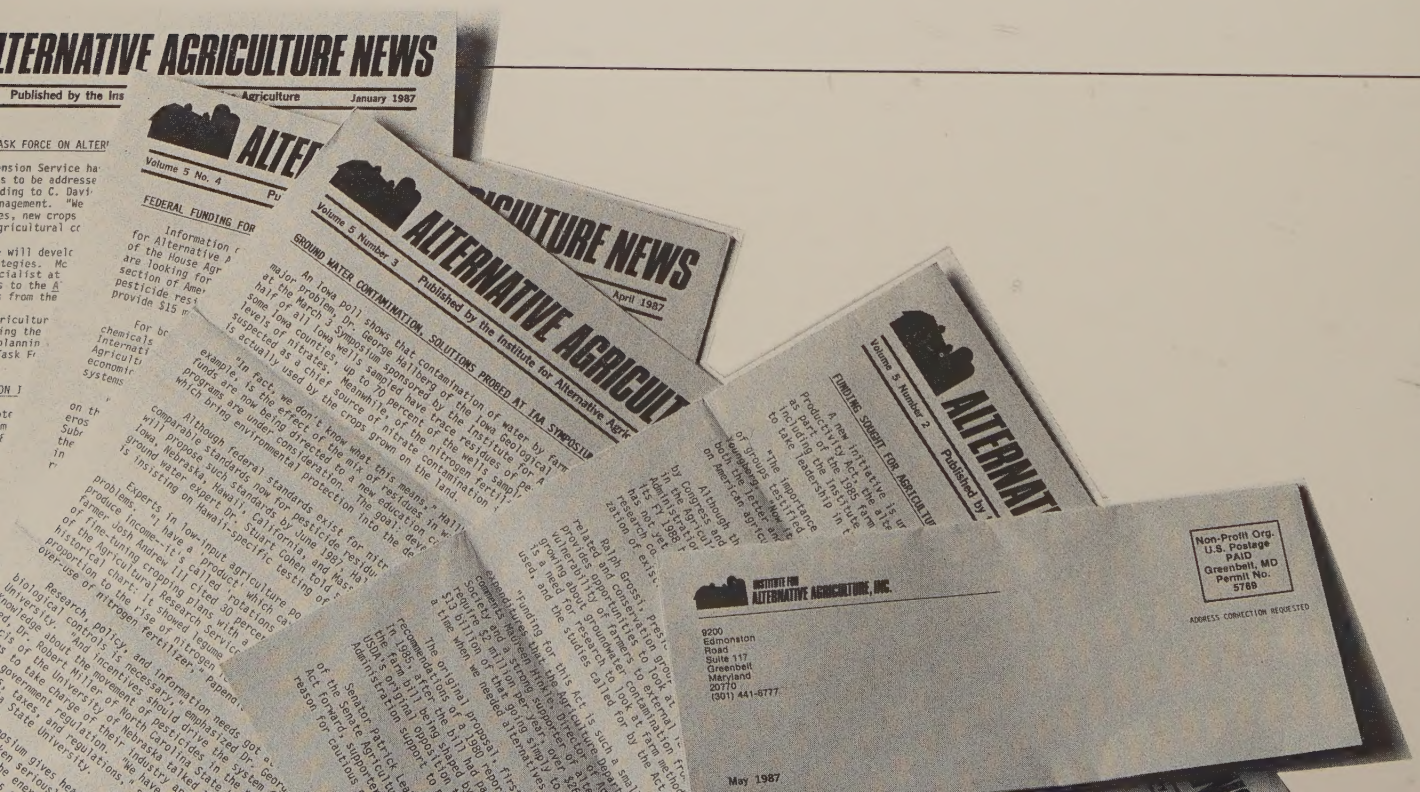
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The Institute for Alternative Agriculture is a nonprofit, tax-exempt research and education organization established in 1983 to encourage and facilitate the adoption of low-cost, resource-conserving and environmentally-sound farming methods. It works closely with producer groups, public research and education institutions, and government agencies in promoting a sustainable agriculture system.

Its programs include providing a national information clearinghouse, serving as a voice for sustainable agriculture in Washington, and developing and implementing research and educational outreach programs. It holds an annual scientific symposium and publishes a monthly newsletter.

The Institute is governed by a grass roots Board of Directors, which includes several commercial-scale organic farmers, and maintains a small professional staff. It is supported by memberships and donations and grants from foundations, corporations, and individuals.

Cover Photo

The cover photo shows chaff being loaded in the field after harvest near Wiseton, Saskatchewan, Canada, by farmer Tony Hill. The pickup system, designed by Mr. Hill, attaches to the front-end loader and picks up virtually the entire chaff pile. The chaff is then moved to the farm where it will be ammoniated and fed to cattle. Photo provided by Jack Kernan, Senior Research Scientist, Saskatchewan Research Council, Saskatoon, Saskatchewan, S7N 2X8.

The economics of collecting chaff

M. R. Olfert, Mark Stumborg, Wayne Craig, and R. A. Schoney

Abstract. *Chaff, a by-product of cereal and oilseed production that is largely treated as waste product, may have significant economic value as a ruminant feed, and its collection and removal may reduce herbicide usage and tillage. We surveyed fifty farms located throughout the Brown, Dark Brown, and Black/Grey Wooded soil zones of Saskatchewan to determine the costs and benefits of their chaff collection systems. Benefits measured or estimated included both the feed value of chaff and agronomic benefits in the form of reduced tillage and herbicide requirements. Costs measured were for equipment and machinery ownership, maintenance and operation, including labor. The survey responses showed that, regardless of the type of collection system utilized, feed-related benefits outweighed the costs under the stated assumptions about prices and methods of assigning costs. Agronomic benefits alone also were sufficient to offset chaff collection costs. The net benefits of chaff collection are related to both the quantity of chaff collected and the distance the material is transported.*

Key words: chaff collection, chaff feed, economics and chaff, agronomic benefits of chaff

Introduction

Low prices for cereals and oilseeds since the mid-1980s, together with rising input costs, have focused attention on a wide array of alternative crops, markets, and production methods on the prairies, as well as on more efficient ways of producing and utilizing existing products and by-products. Environmental concerns and the notion of "sustainability" have increased the pressure on producers and consumers to recycle and reduce wastes. Diversification of agriculture-based economies into value-added activities has become urgent with the downturn in grain prices. Relatively attractive prices for feeder calves and high and rising hay prices have led to a search for less expensive and more readily available substitutes for hay. These general trends, together with technological improvements in collecting, packaging, and hauling, have renewed interest in the use of chaff as livestock feed and as industrial raw material.

Chaff is the residual material from cereal crops that passes over the combine shoe and falls to the ground or is spread behind the combine. This material consists of glumes, hulls, parts of heads, short straw, leaves, and weed and crop seeds. The size of chaff particles is much smaller than that of straw and requires different collection and handling methods. The chaff is collected directly from the combine shoe using an auger located behind the combine shoe and a blower assembly that blows the chaff into a small trailer wagon. When the wagon is full, the combine operator dumps the load off the wagon into the field. The chaff piles are then picked up after harvest.

Chaff has potential as a large, inexpensive supply of ruminant feed (Craig, 1988; Knipfel, 1984). The quality of the chaff varies with the type of grain, co bine efficiency, weather, moisture co tent, and the size of the plants. Ammo ation (addition of nitrogen) improves t protein content and digestability of ch (Craig, 1988). Utilization of chaff as fe is restricted almost exclusively to t farm on which it is collected. The co associated with collecting and tra porting chaff, and its feed value, will d termine its viability as a feed substitu for or complement to hay. Its econom viability will be very sensitive to the d tance it must be transported because its low bulk density (Coxworth et a 1981).

Benefits of chaff collection may al include reduced tillage requirements a herbicide usage. Heavy concentratio of chaff in windrows may cause po seed placement, phytotoxicity, or hi short-term nitrogen demand because chaff decomposition, all of which m contribute to poor stand establishme and growth in the subsequent cr (Craig, 1988). The presence of grain a weed seeds in the chaff may create pro lems in the form of volunteer plants the next crop, with implications for bo tillage requirements and herbicide app cation.

The loss of erosion protection and n trients that may be provided by crop re dues must also be considered as a pote tial cost of chaff collection (S Conservation Notes, 1987). The remov of chaff from the land, however, cont butes less to soil erosion than does t removal of straw (Rennie, 1986). study by Campbell et al. (1989) indicat that the removal of straw for 18 of years from a three-year rotation in t Black soil zone at Indian Head, Sa katchewan, resulted in no reduction organic carbon and a 5 percent reducti of organic nitrogen. Therefore, the moval of chaff may have little or no fect on the soil nutrient balance.

In the long run, chaff collection m influence aspects of the farm enterpr

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such as size of the herd, the type of equipment, and land use. An analysis of the long-run effects of chaff collection would require consideration of these structural changes. This study examines only the short-run benefits and costs of chaff collection, based on a survey of chaff collectors. The objectives of the survey were to determine collection costs for commonly used chaff collection systems in Saskatchewan, the economic value of the chaff as a ruminant animal feed, and the potential agronomic benefits of collecting chaff. We compare the short-run costs of production to the potential economic feed value of the chaff. We also estimate the economic effects of varying the quantity of chaff collected and the distance hauled.

Methods

We surveyed 50 randomly selected producers who collect chaff (from an estimated population of 500) located throughout the three major soil zones of Saskatchewan (Brown, Dark Brown, and Black/Grey Wooded) to estimate the cost of collecting, transporting, and feeding chaff. Data were collected on the type, size, age, replacement cost, and current market value of machines, and on the time spent and distances hauled. Information was gathered for each machine involved in the packaging, collection, and transportation of the chaff, tillage and herbicide application, and the swathing, baling, collection, and transportation of hay or straw bales. More subjective information about the agronomic benefits of chaff collection was also recorded, including the potential savings in tillage and herbicides.

The University of Saskatchewan's Top Management computer model was used to convert the questionnaire data into costs in 1988 Canadian dollars (Schoney, 1988). The Top Management model translates information about the physical characteristics of production (machinery, enterprises, time requirements, yields, rotations, etc.) into annual costs and revenues.

We consider both variable and fixed components of costs. The former vary directly with the amount of chaff collected (number of tonnes). The latter are constant, representing the cost of the machinery and other overhead. Variable costs included labor, fuel, lubricants, and repairs. Variable costs of harvesting the chaff depend on quantity (tonnes). Variable transportation costs depend on quantity and distance hauled. Fixed costs consist of a capital recovery charge that has two components: depreciation calculated as a percentage of a declining balance (as opposed to 'straight line' depreciation) and an investment charge that represents the foregone interest earnings on the money tied up in the machinery (purchase price or resale value). Both must be charged even for a machine that is already owned.

Where the primary function of a machine used in chaff collection or transport was not related to the chaff system (e.g., a combine, tractor, or truck), only 5 percent of the variable costs and none of the fixed costs of the machine were allocated to chaff. Labor for each system was valued at $8.50/hr. Annualized fixed cost of equipment ownership was calculated two ways: first, using current "as is" fair market value estimated by the survey respondents (FC_1) and second, using new equipment costs (FC_2).

Cost-quantity and cost-distance relationships were generalized by using the survey data to construct weighted mean cost values. Variable harvesting costs were weighted according to the quantity harvested. The repair component of variable transportation costs was weighted according to tonne-kilometers of transport. To extrapolate from the data, we assumed that labor and fuel costs associated with loading, unloading, and piling chaff are proportional to quantity and that costs associated with transportation are proportional to distance and quantity.

The monetary value of chaff as feed was computed from the nutritive (crude protein, total digestible nutrients, minerals, etc.) of chaff samples analyzed by a feed testing laboratory, supplemented with protein to correct for quality differences. This was compared with the nutritive value of a standard hay/barley ration for beef cows (Saskatchewan Department of Agriculture, 1987). Based on this nutritive equivalency, and 1988 prices of hay and barley, the value of chaff was estimated as approximately 75 percent that of hay.

Agronomic benefits were estimated from information provided by survey respondents on cropping inputs, yields, weed populations, and general crop and summerfallow conditions. The cost savings as a result of tillage and herbicide applications avoided because of chaff collection were calculated separately for variable and fixed costs. Variable costs were based on the Top Management model estimates as described above for chaff collection. The entire fixed costs of power units (based on FC_1) were included in the calculation of tillage and herbicide savings where the power unit was used primarily for those herbicide application or tillage operations. In the case of reduced herbicide usage, savings also included the direct cost of the herbicide. Where the chaff was used as feed and agronomic benefits also were reported, the net monetary value of the two is additive.

We compared the feed and agronomic benefits to the costs incurred in chaff collection. Since information about agronomic benefits was available for only a subset of the survey, benefit-cost (b/c) ratios were calculated separately for feed value only, agronomic benefits only, and feed value plus agronomic benefits.

Five distinct systems for collecting chaff from small piles in the field were identified in the questionnaire. These systems, in descending order of sophistication, were: chaff blower (Chaff-O-Matic) (Figure 1); stack wagons (Figure 2); push off stackers (Figure 3); and vacuum blowers (Figure 4). The fifth combine chaff collection system (Figure 5), which consisted of leaving the chaff piles in the field for cattle to feed on or to be destroyed by burning, was not analyzed in detail.

Results and discussion

Collection costs and feed value

The results presented in Table 1 show the costs per ton for systems 1 through 4, averaged over all farms, the number of respondents, the average quantities of chaff collected, and the relative impor-

Figure 1. Chaff blower.

Figure 2. Stack wagons.

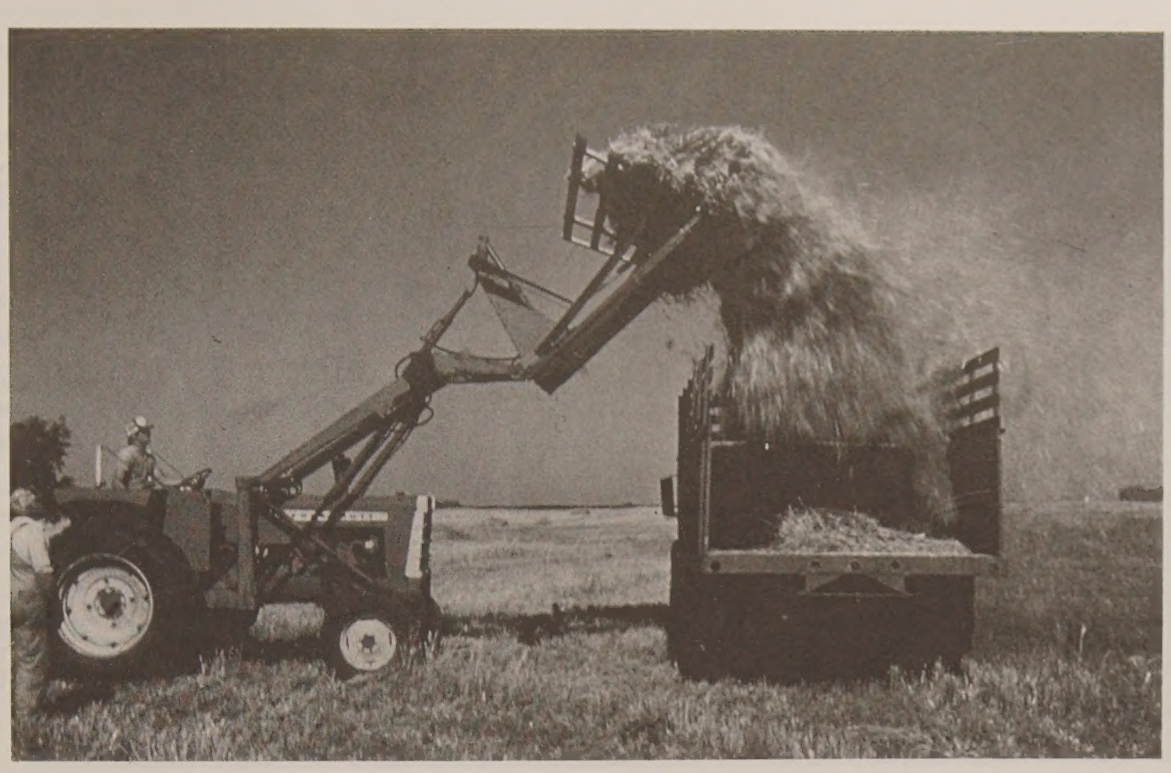

Figure 3. Push off stackers.

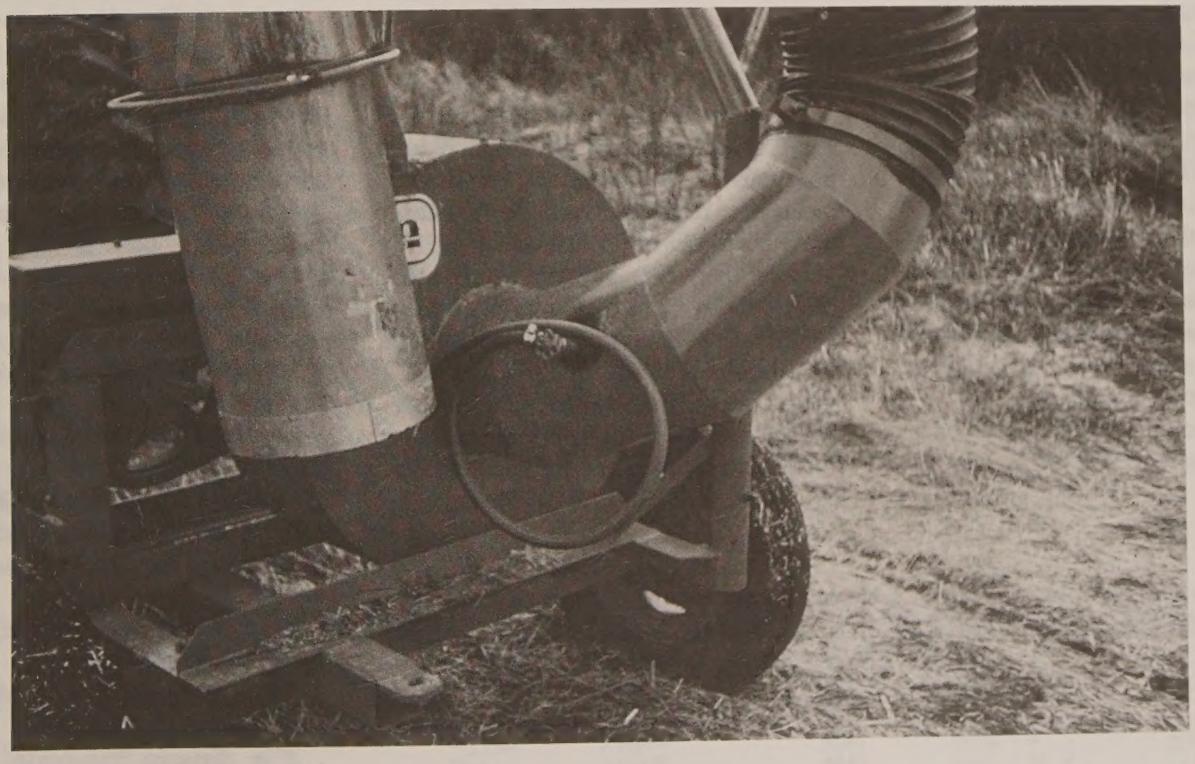

Figure 4. Vacuum blowers.

Figure 5. Combine chaff collection system.

tance of labor costs in total costs. Average total costs in Table 1 are simple averages over all survey respondents regardless of quantity collected or distance transported. These costs are approximately half those estimated by the Saskatchewan Department of Agriculture (1983). They assumed the purchase of new chaff collection equipment and straight line depreciation and included power units and combines in the calculation of fixed cost. Our survey shows that producers have collected chaff for several years at a lower cost by using and adapting existing equipment.

Chaff collection systems are labor intensive, as shown in Table 1. Labor is the largest variable cost component and exceeds fixed costs. The cost of labor varies inversely with the degree of sophistication of the chaff collection equipment.

Historical prices for tame hay from 1960 to 1985, adjusted for inflation and productivity improvements, yielded a mean price of $67.58/tonne, with a standard deviation of $17.30. Chaff, at 75 percent the value of hay, would thus have a mean value of $50.69 per tonne. The mean plus or minus one standard deviation implies that the value of chaff would range from $37.71 to $63.66/tonne two-thirds of the time. Under these assumptions the feed value of chaff exceeds the average cost for all system represented in Table 1.

Cost-quantity and cost-distance rela tionships derived from the producer sur vey were used to construct the weighte mean cost values presented in Table 2 For each system, cost components calcu lated for each farm were weighted by th quantity of chaff collected by that farm in determining costs per unit. The aver age total costs per tonne presented i Table 2 were calculated from Equatio 1:

$ATC = TFC/N + HVC_t + TVC_t + (TVC_{td} * d)$ (1)

where ATC = average total cost ($ tonne)

TFC = total fixed costs ($)

N = quantity collected (tonnes)

HVC_t = harvest variable cost ($ tonne)

TVC_t = transport variable cost, unr lated to distance ($/tonne)

TVC_{td} = transport variable cost, di tance related ($/tonne-km)

d = distance transported (one-wa km)

TVC_t includes loading and unloadi

Table 1. Average chaff collection costs (CDN$) and quantities (fixed costs = FC_1), systems 1 to 4, from survey of chaff collectors, 1988.

System	Number of farms	Average quantity collected (tonnes)	Average total cost ($/tonne)	Labor as % of total costs per tonne
1) Chaff-O-Matic	8	158	24.30	28
2) Stack Wagons	23	145	20.90	35
3) Push Off Stackers	7	68	15.10	42
4) Vacuum Blower	6	60	33.20	48

Table 2. Weighted average total cost of chaff and cost components, one-way transportation distance of 1 km, systems 1 to 4. (Computed from survey of chaff collectors, Table 1 and Eq. 1)

Cost Component	Collection System			
	Chaff-O Matic	Stack Wagon	Push Off Stacker	Vacuum Blower
Weighted variable costs				
Harvest ($/tonne)	2.82	2.13	2.02	2.46
Transport				
($/tonne)	7.66	16.03	7.77	10.46
($/tonne-km)	0.64	0.66	0.95	0.69
*Total fixed costs per farm** ($/farm)				
Producer valued (FC_1)	692.26	470.89	61.08	111.80
New equipment (FC_2)	1091.37	982.67	214.90	186.76
Weighted average fixed costs ($/tonne)				
Producer valued (FC_1)	4.38	3.25	0.90	1.86
New equipment (FC_2)	6.91	6.78	3.16	3.11
Weighted average total costs ($/tonne for 1 km distance)				
Producer valued (FC_1)	15.50	22.07	11.64	15.47
New equipment (FC_2)	18.03	25.60	13.90	16.72

* For each of the 4 systems, total fixed costs were averaged over all farms. Weighted average fixed costs per tonne is total fixed costs per farm divided by the average quantity of chaff collected on those farms.

costs, while TVC_{td} includes time and fuel costs that vary with distance hauled. Fixed costs were assumed to be unrelated to the distance the chaff was transported between a collection site and the farm.

The component of transportation costs that varies with distance hauled (TVC_{td}) was computed per tonne-kilometer, so weighted average total cost values in Table 2 represent per tonne costs for transporting chaff a one-way distance of one kilometer. For example, for System 1, the average total cost of $15.50 (assuming FC_1) would increase by $.64 for every additional kilometer the chaff is transported.

Equation 1 can be used to solve for either the break-even transportation distance (for a given quantity) or break-even quantity (for a predetermined distance) for any price (imputed or actual value) of chaff. For example, if chaff has a feed value of $37.71/tonne to the farmer and the one-way transportation distance is 16 km, the appropriate break-even quantity for System 1 (using FC_2) is:

$$\$37.71 = 1091.37/N + (2.82 + 7.66) + (0.64 \times 16)$$

$$N = 64 \text{ tonnes}$$

A minimum of 64 tonnes per year would be necessary in order for the feed value of chaff to offset the costs.

To determine a break-even transportation distance for any quantity, if the same producer needed 150 tonnes of chaff, the maximum transport distance would be 31 km before the collection costs exceed the imputed value of chaff to the producer. The critical distance and quantity will vary with the system being employed. Alternatively, if both tonnage and transportation distance are known, the calculated average total cost can indicate the critical price of hay (equal to ATC / .75) that would make chaff collection profitable with each system. Table 3 summarizes the average total cost results of applying Equation 1 for selected quantities, for both FC_1 and FC_2, and for a one-way transportation distance of 8 km (an average transportation distance for survey respondents).

Estimating the net benefits of chaff collection

The survey for the Brown and Dark Brown soil zones found the following:

1) 50 percent of producers eliminated at least one tillage operation per year;

2) 67 percent of producers either reduced herbicide use or eliminated at least one tillage operation per year;

3) 69 percent of producers who had cattle and fed chaff were able to substitute chaff for at least half of their on-farm hay/straw requirements. An additional 16 percent were able to substitute chaff for 25 to 50 percent of their hay/straw requirements.

The Black and Grey Wooded soil zones were excluded from this part of the analysis because different cropping practices preclude many of the agronomic benefits.

Table 4 shows the overall system benefit to cost ratios (b/c) for producers in the Brown and Dark Brown soil zones who reported agronomic benefits and for those who reported only feed-related benefits. The b/c ratios are weighted averages taking into account each farm's b/c ratio and the amount of chaff they collect. The results show that a producer who realizes tillage/herbicide savings and feeds chaff can achieve a b/c ratio of 2.35.

Table 3. Average total costs per tonne of chaff collection and transportation for selected quantities, transport distance of 8 km (one-way), systems 1 to 4.

Tonnes	Chaff-O-Matic		Stack Wagons		Push Off Stacker		Vacuum Blower	
	FC_1	FC_2	FC_1	FC_2	FC_1	FC_2	FC_1	FC_2
	$/tonne							
50	29.45	37.43	32.86	43.09	18.61	22.18	20.68	22.18
100	22.53	26.51	28.15	33.27	18.00	20.31	19.56	20.31
300	17.91	19.24	25.01	26.72	17.59	18.11	18.81	19.06
500	16.99	17.78	24.38	25.41	17.51	17.82	18.66	18.81

Table 4. Chaff collection system benefits relative to weighted average costs, brown and dark brown soil zones.

System Benefits	Benefit/Cost ratio	
	Agronomic Benefit	No Agronomic Benefit
Reduced tillage or herbicide application	1.28	—
Imputed market feed value	1.07	1.01
Total	2.35	1.01

Conclusions

The results from a survey of 50 Saskatchewan producers show that cereal chaff collection is an economical way of obtaining a quality ruminant animal feed. Chaff collection can mitigate the effects of drought because it provides an alternative to hay in meeting ruminants' demand for fiber. For producers who remove chaff from all their land, the survey results also indicate significant input cost reduction (reduced tillage and herbicide use). Evidence to date does not suggest negative side effects of chaff collection in increasing erosion or loss of soil nutrients.

The limitations imposed by the assumption that labor is available at a fixed price of $8.50/hr should be noted. Although this price may accurately represent the next best alternative of some farm labor for most of the year, it probably seriously underestimates the value of the farm operator's labor during critical periods such as harvest. If chaff equipment introduces any delays during harvest, the value of labor that is diverted from harvesting would be higher than $8.50. Therefore, the availability of labor, reliability of the chaff equipment, and the ease with which the attachments may be disengaged must be seriously considered.

The analysis presented in this paper suggests a means for farmers to assess the distances over which they may economically collect and transport chaff and the influence of the size of operation on cost per tonne for four systems of chaff collection. It also shows how the current price of hay may be used to determine the relative economic advantages of chaff and hay for feed uses.

Two sites, Swift Current (Brown soil zone) and Melfort (Black soil zone) were established in 1988 to determine the agronomic benefits or detriments of chaff collection, including changes in organic matter, nutrients, erodibility, and productivity. Results are expected by 1998. These data will define more clearly the agronomic effects of chaff collection. Further research is required on the changes in farm structure that may result from widespread substitution of chaff for hay. The technology of industrial uses of chaff requires more detailed specification before their economic viability is known.

References

1. Campbell, C. A., K. Bowren, G. Lafond, I Janzen, and R. P. Zentner. 1989. Effect of cr rotations on soil organic matter in two bla chernozems. Soils and Crops Workshop, Febr ary 16-17, 1989, Saskatoon, Saskatchewan.
2. Coxworth, E., W. Coates, B. Zuk, and W. Crai 1981. Crop Residue Densification: Technic and Economic Feasibility. SRC Publication N C-711-10-B-81. Saskatchewan Research Cou cil, Saskatoon.
3. Craig, W. 1988. Chaff collection costs and pr cessing options. SRC Publication No. R-811- E-88. Saskatchewan Research Council, Sa katoon.
4. Knipfel, J. E. 1984. Beef cattle grazing and wi ter feed during drought. Agriculture Canad Weekly Letter No. 25, August 17. Agricultu Canada Research Station, Swift Current, Sa katchewan.
5. Rennie, D. 1986. You've gotta rock the boat you're gonna make waves. Grainews, April 1 pp. 82-83.
6. Saskatchewan Department of Agricultur 1983. Chaff collecting, hauling and packin costs. Farm Business Management Section, Sa katoon, June.
7. Saskatchewan Department of Agricultur 1987. Potential of chaff. Farm Managemer Bulletin. Economics Branch, April.
8. Schoney, R. A. 1988. Results of the 1988 Sa katchewan Top Management Workshops. Bu letin FLB 88-01. Department of Agricultura Economics, University of Saskatchewan, Sa katoon.
9. Soil Conservation Notes. 1987. Tillage practice that reduce soil erosion. Save Our Soils ERD Project. ISSN 0829-5751, Agdex 572, August

Consumer Concern About Food Safety Increasing, New Survey Finds

The percentage of people who feel it is extremely or very important for produce to be certified safe by residue testing has increased from 52 percent to 68 percent in just two years, according to the annual "Fresh Trends" survey done by *The Packer* magazine. The survey found that 82 percent believe growers can greatly reduce their use of chemicals in production without diminishing quality, and 22 percent say it is extremely or very important that an item be grown organically. It also found that 59 percent of consumers agree that the potential health benefits of eating fresh fruits and vegetables outweigh the potential risks from possible pesticide residues.

Of those surveyed, 46 percent of consumers say they are more concerned about residues, such as pesticides, than a year ago; the same number are more concerned about preservatives and chemical additives in food than they were a year ago. Three-quarters, or 75 percent, said they were just as concerned or more concerned about the use of waxes and coatings on fresh produce as they were a year ago.

Sustainable agriculture: The wildlife connection

Ann Y. Robinson

Abstract. *Wildlife and fish have much to gain from the movement toward alternative, sustainable agricultural practices. Interrelated reasons for the habitat improvements to be expected from a change to sustainable systems include reduced use of agricultural chemicals, better care of the soil, and reintroduction of greater landscape diversity. The most well-documented benefits would result from reduced use of agrichemicals, which often are toxic and frequently change the structure and composition of available food and cover. The wildlife benefits of erosion prevention and landscape diversification are less well-documented but may be as significant for habitat improvement. The opportunities to enhance habitat using sustainable farming methods are beginning to receive increased attention from wildlife professionals. As a result, efforts are under way to expand use of sustainable methods on farmlands managed by the U.S. Fish and Wildlife Service.*

Key words: wildlife, fisheries, pesticides, national wildlife refuges, landscape diversity

Wildlife and fish have much to gain from a move away from what has become known as conventional agriculture, toward more sustainable, alternative practices. There are several interrelated reasons for the habitat improvements that can be expected from a change to sustainable farming systems. Three deserve special attention: reduced use of agricultural chemicals; better care of the soil; and reintroduction of greater landscape diversity.

The most evident advantage of alternative systems for wildlife is the reduced use of fertilizers and toxic chemicals, particularly insecticides, but also herbicides. Careful attention to maintaining and even improving soil, and thereby preventing erosion and associated water pollution, is another significant habitat benefit of sustainable farming, particularly for fish and other aquatic life. Another reason alternative farming promises a more hospitable landscape for wildlife is the emphasis on diversifying crops and livestock. This results in a wider variety of niches for wild species.

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The opportunity to improve habitat using sustainable farming methods is receiving increased attention from wildlife professionals. A changing approach to management of national wildlife refuges reflects this. Although low-input methods have been employed on a few refuges since the late 1970s, efforts are under way to expand this approach.

Damage to wildlife caused by conventional practices

Threats to wildlife and fish from agricultural chemicals

Use of agricultural chemicals continues despite the negative consequences of exposing nontarget organisms. The quantity of agricultural chemicals sprayed, injected, and spread on the land has increased dramatically in recent decades. The total amount of pesticide active ingredients applied on farms increased 170 percent between the early 1960s and 1982, while use of nitrogen fertilizer increased more than fourfold, from 2.7 to 11.9 million tons. Currently, about 19 million tons of fertilizers are used annually (National Research Council, 1989).

Pesticide use is highest on fruits and vegetables and field crops, including cotton, wheat, and corn. It tends to be much lower on hay crops, pasture, and rangeland. The need for pesticides has increased in large part because of specialization in one or two crops, and correspondingly, reduced use of rotations. These changes in farming systems over the last several decades have been damaging to wildlife (Dahlgren, 1967; Vance, 1976; Farris et al., 1977; Menzel, 1982; Graber and Graber, 1983; Potts, 1985). For example, in Illinois, a recent attempt to model agriculture's ecological impacts suggests that the expansion of row crop farming and decrease in oat-hay rotations explains over 90 percent of the approximately 50 percent decline in small game taken by hunters over the past three decades (Warner, 1991).

Persistence of organochlorines

Most persistent organochlorine (OC) insecticides, including DDT, aldrin, dieldrin, and heptachlor, have been banned or severely restricted in many countries, including the U.S. However, many continue to be manufactured here for sale in countries where they are still allowed, and there have been reports that they continue to be used illegally here (Henny and Herron, 1989; Turnbull et al., 1989). Even if these chemicals were no longer used inside our borders, migratory birds are exposed to them in countries that still allow their use.

The most damaging trait of the OCs is their tendency to accumulate in lower organisms and increase in concentration successively up the food chain until toxic concentrations are consumed by the higher animals. They are infamous for causing eggshell thinning in flesh-eating species such as raptors, gulls, and brown pelicans, and tend to persist in the environment for years.

Toxicity of newer pesticides

Most insecticides in widespread use today are organophosphates (OPs) and carbamates, which are relatively short-lived. Their persistence varies from hours to months. Although they do not generally concentrate in the food chain, they can be very toxic. They kill by disrupting enzymes that control nerve impulse transmission and muscular function. Wildlife ecologists have tended to tolerate the new chemicals, not because they are harmless, but because they are a lesser evil than the persistent OCs. Even so, some new insecticides are more acutely toxic to wildlife than the old OCs (Stickel, 1973; Stinson and Bromley, 1991).

More information is needed on the impact of the newer compounds on biological systems, particularly their long-term effects. What is known suggests that insecticides and nematicides are the most damaging to animal life. However, herbicides also can be very harmful, especially to the structure and composition of habitat and food sources. Synthetic fertilizers cause problems, too. Overfertilization has been blamed for declining water quality in many lakes and streams where nutrient enrichment leads to eutrophication and subsequent fish kills (Menzel, 1982; Clark et al., 1985; Conover, 1987).

The method of applying a chemical can make an important difference in its harmfulness to wildlife. Many pesticides are now applied in granular form, which can be mistaken for food and grit by birds and small mammals. This is most likely to be a problem for smaller species (Balcomb, 1984; Bryan and Pease, 1990). Increasing use of aircraft to apply pesticides increases drift into nontarget areas, which can poison insects, wildlife, and plants. Airborne pesticides often travel far beyond field boundaries, from many feet to many miles, depending on the chemical and the weather (Ware et al., 1970; Tome and Grue, 1990a; Capel, 1990).

Bird poisonings

Many studies and documented reports indicate that the modern OP and carbamate insecticides are toxic to wildlife. The best documented impacts are on birds. Signs of poisoning in birds include wing droop, lack of coordination, excessive salivation, lethargy, diarrhea, and labored breathing.

The pesticide carbofuran by itself is considered to cause an estimated 1 to 2 million bird deaths per year, according to an analysis by the U.S. Environmental Protection Agency (1989). Widely used on corn and other crops, it has been documented as killing sandpipers and fulvous whistling ducks (Flickinger et al., 1980), lapland longspurs, California gulls (Leighton and Wobeser, 1990), bald eagles, and other species of songbirds, waterfowl, and birds of prey (Balcomb, 1983; U.S. Fish and Wildlife Service, 1989).

The EPA concluded in 1989 that the risks of using carbofuran, already a restricted-use chemical, outweighed the benefits. In 1991, Furadan's manufacturer, FMC Corp., and the EPA negotiated a settlement phasing out most uses of the chemical by 1994 (National Coalition Against the Misuse of Pesticides, 1991). The state of Virginia had already issued an emergency rule banning use of granular carbofuran after June 1, 1991, because of documented bird poisonings. Previously, the state had enacted restrictions on the chemical as part of a plan to safeguard birds, particularly bald eagles (Virginia Dept. of Agriculture and Consumer Services, 1991); but careful monitoring showed that, even with the restrictions, birds were still dying.

The insecticides ethyl and methyl parathion, dimethoate, and chlorpyrifos, which are used on corn, wheat, sorghum, and sunflower, can also be toxic to birds, including grassland birds and waterfowl (Grue et al., 1988; Forsyth, 1989). As little as one-half pound per acre of methyl parathion, a common application, has been found to make pheasants sick and cause limited mortality. Ethyl parathion, which is considered less toxic to birds, has caused sickness and death in young pheasants in field trials (Stickel, 1973). Ducklings are especially vulnerable. In one field study, methyl parathion reduced survival of mallard, wood duck, and teal ducklings by 43 percent. Although the teal ducklings had the highest rate of survival on the untreated field, none survived the chemical treatmen (Brewer et al., 1988).

Field studies have found that the O insecticides methamidophos and di methoate, used on potatoes and alfalf respectively, kill sage grouse. They hav also been implicated in declines of othe gamebirds, including ring-necked pheas ants and gray partridge (Blus et al. 1989). Disulfoton, a popular systemi chemical used on wheat, cotton, sor ghum, and potatoes, is moderately t very highly toxic to upland gamebird and mallards and highly toxic to mam mals, including rats, mule deer, jackrab bits, cows, and horses (Brewer, 1989) Terbufos, a common corn insecticide-ne maticide, is acutely poisonous, even a low concentrations, to songbirds, bob white quail, dogs, and rats (Balcomb 1984; Kendall et al., 1990).

When they are not harmed directly b the chemical application, birds and othe wildlife often become victims of "sec ondary" poisoning after they eat dea and dying invertebrates, rodents, o smaller birds (Stickel, 1973; Balcomb 1983; Henny et al., 1985). Insecticide also can cause behavioral changes an physiological problems that reduce th chance for survival. These include de creased food consumption, excessiv "noisiness," difficulty keeping up a nor mal pace during brood movement, an increased susceptibility to predation an cold (Grue et al., 1986; Kendall et al. 1990; Martin and Solomon, 1990). Kes trels dosed with methyl parathion exhib ited abnormal hypothermia (Rattner an Franson, 1983). The same chemical als reduces bobwhites' predator escape re sponse (Galindo et al., 1984) and cause mallards, wood ducks, and teal to aban don their broods (Brewer et al., 198 Bennett et al., 1990).

Herbicides are much less toxic to wild life than insecticides, but they also pos threats (U.S. Fish and Wildlife Service 1989). Most herbicides are relativel nontoxic to vertebrates, but paraquat, weed killer used in no-till farming, is a exception. It affects growth and surviva of some birds, including kestrels, cause birth defects in mallards (Castral 1987), and damages birds' skin, nail cornea, liver, kidney, and respirator tract (Benson et al., 1985). It also is toxi

to some rodents, an important food for raptors.

Herbicides often contain other ingredients that can increase their toxicity (Buhl and Faerber, 1990). For example, petroleum products, including ordinary fuel oil, sometimes are used as a mixing agent. Even minute quantities of fuel oil can be very toxic to developing embryos (Albers, 1978).

Herbicides also harm wildlife indirectly when they are used to eliminate the little remaining cover in an area, as when fencerows, right-of-ways, and roadsides are cleared. In one Iowa study, herbicide use was the only consistent difference that explained why bird habitat was significantly better in organic fields than in nearby conventionally managed fields (Gremaud, 1983). A 15-year study in Great Britain concluded that use of herbicides was the most important cause of the dramatic decline of partridges in that country and possibly worldwide (Potts, 1985).

Pesticides damage to amphibians, fish, and invertebrates

The impacts of agricultural chemicals on many other wild creatures are less well-documented, but nevertheless warrant serious concern. Again, insecticides pose the greatest threat. Generally nonspecific, insecticides kill a wide range of insects, not just the few that qualify as pests. By removing insects from the food chain, these chemicals reduce the food available for birds, amphibians, and other animals.

Pesticides are considered one of the three main reasons for the worldwide decline of frogs, salamanders, and other amphibians (Rabb, 1990). The devastating effects of insecticides on honeybees are well-known, ranging from severe disruption of their normal activities to death (Johansen, 1977; Barker and Waller, 1978; Cox and Wilson, 1984; Kevan et al., 1990).

Pesticides also can disrupt the tiny but important animals and plants that dwell in the soil (Edwards, 1965; Way and Scopes, 1965). Although the role of these organisms is not fully understood, scientists are giving greater recognition to the part they play in breaking down toxic materials, forming organic matter, improving soil structure, and preying upon pests. Earthworms are gaining renewed respect for their role in improving soil. Their burrowing enhances water filtration, and they also provide natural fertilization. Earthworm populations have declined in conventional fields, and in some cases even disappeared after soils have been treated repeatedly with chemicals (Stickel, 1973; Ducey et al., 1980; Klaas, 1982).

Aquatic invertebrates, an essential food for fish and waterfowl, particularly laying females and young ducklings, are very susceptible to pesticide poisoning. The insecticide methyl parathion alters the mix of aquatic invertebrates in wetlands. It nearly eliminates dragonflies and significantly reduces the populations of many other insects and invertebrates either by poisoning them directly or by altering their behavior, which increases susceptibility to predation (Tome and Grue, 1990b). Disulfoton, an insecticide often used against grain pests, is considered only moderately toxic to most freshwater fish, but it can be highly toxic to freshwater invertebrates (Brewer, 1989). Fenvalerate, a synthetic pyrethroid insecticide, is toxic to a variety of aquatic invertebrates (Grue et al., 1990).

Aquatic communities are especially vulnerable to pesticides and fertilizers. Fish are threatened in many ways: they may be poisoned directly, their food and cover may be eliminated, or the water in which they swim may become overenriched and deoxygenated. Many aquatic organisms absorb chemicals directly into their bloodstream through skin or gills (Klaas, 1982). OP insecticides have many visible effects on fish including hyperexcitability, lethargy, swimming rapidly in circles, severe muscular contractions, and abnormal positioning of fins (Goodman et al., 1979). For example, the insecticide/nematicide aldicarb, which is prone to runoff and leaching, affects the behavior of freshwater fish and causes significant liver and kidney damage (Kumar and Pant, 1984).

The degree to which fish are harmed depends on many factors, including water temperature and how quickly the water supply flushes through the system. Lakes are more vulnerable to pesticide poisoning than quick-flowing streams. Insecticides are much more likely than herbicides to harm fish and aquatic invertebrates, but common weed killers also can be harmful. Herbicides can poison insects, insect larvae, and other invertebrates (Buhl and Faerber, 1990) and reduce or eliminate plant species that are important foods for insects and fish (Klaas, 1982). The negative effects can be much greater when more than one chemical pollutant is present. A California study of molinate and thiobencarb, two herbicides used on rice, found that each harmed juvenile fish by itself, but that they were about twice as likely to be lethal when residues were combined (Finlayson and Fagella, 1986).

In many watersheds, fertilizers, including manures, may be a greater concern than pesticides. Researchers have found that conventional farmers regularly apply much more fertilizer than crops can use (Agricultural Law and Policy Institute, 1988; Duffy, 1991). Lost fertilizer often ends up in water supplies, where it stimulates high rates of plant and algae growth, thereby reducing or eliminating dissolved oxygen.

Wildlife benefits of alternative methods

Soil conservation

The benefits for fish and wildlife of reducing farm chemical use are evident, but sustainable agriculture also offers other advantages. One aspect of the alternative approach that bodes well for fish particularly, but also for other wildlife, is an emphasis on protecting, improving, and building soil.

Several sustainable practices that are ideal from this standpoint are good for wildlife. These include use of rotations, avoidance of synthetic fertilizers, and more careful husbandry of manures. Low-input systems also are likely to provide cover to protect soil from wind and water erosion during more of the year than conventional farming systems (Flach, 1990).

Sedimentation from soil erosion is the primary threat to fish in many water-

sheds in agricultural America (Menzel, 1982). Soil particles damage aquatic life along the entire food chain, from microscopic plants and animals to valuable game fish. Eroded soils from intensive farming operations often carry nitrogen and phosphorus from fertilizers and manures that lead to hyperenrichment or eutrophication. Any agricultural system that takes better care of the land is likely to be beneficial for fish and aquatic communities. Sedimentation from agricultural runoff appeared to be the major cause of large shifts in insect communities in three streams in North Carolina (Lenat, 1984). In Illinois and Missouri, excessive siltation from erosion was a principal cause of the disappearance of native fish species (Smith, 1971; Berkman and Rabeni, 1987).

Tillage and soil conservation practices have important effects on terrestrial habitat. As tillage increases, the value of row crop habitat decreases for most bird species, except for a few that favor areas with little vegetation, such as the horned lark. One concern about low-input systems is that they depend more on cultivation and tillage as a way to avoid herbicide use, so that they may reduce habitat. However, other measures are regularly used in sustainable systems that help mitigate the effects of increased tillage. These include the reduced use of pesticides, smaller field size, and practices that provide increased habitat and diversity of cover and food sources, such as windbreaks, shelterbelts, and strip cropping.

In some cases, no-till is replacing costly structural measures like terracing as the answer to erosion. No-till can fight soil loss effectively and can enhance habitat for some bird and rodent species (Best, 1986; Gremaud, 1983). However, it usually requires heavy doses of chemicals, including "burn down" herbicides that harm nestling kestrels and a variety of other birds and mammals (Hoffman et al., 1985). Reduced tillage fields also tend to retain other undesirable features, such as reduced crop diversity and large field size. In addition, no-till may encourage conversion of steeper non-croplands to row crops, offsetting any modest wildlife gains that occur on existing fields (Cacek, 1984).

Diversity

Diversity is considered a key to ecosystem sustainability. Maximizing the advantages of diversity in managed agricultural ecosystems is also a cornerstone of alternative agricultural methods. In general, a sustainable farm will have more diversity, more wildlife habitat, and more wildlife than a conventional farm (Papendick et al., 1986).

Several studies support this conclusion. In Illinois, Vance (1976) found that, as conventional cash-grain farming increased in an area, field size more than doubled, with a corresponding decrease in odd areas such as fencerows that provide preferred wildlife habitat. Over the same period, prairie chickens disappeared and bobwhite quail declined by 78 percent. Nebraska research comparing an organic farm to conventional dryland and irrigated farms credited its much higher avian activity to greater habitat diversity and the "edge effect" resulting from the organic farm's wider array of crops and smaller fields (Ducey et al., 1980). The organic farm also had more diverse and abundant small mammals and invertebrates, including earthworms and predatory insects.

An Iowa study compared several conventional and organic fields, finding eight times more birds on the organically farmed fields (Dahlgren, 1984). The difference was attributed mainly to the increased amount of crop litter, seed abundance, pasture, and brushy cover on the organic farm. Preliminary results of research under way in Canada on several pairs of organic and conventional farms also indicate that there are consistently more bird species and greater abundance on organic farms (Freemark et al., 1991).

Different crops near each other benefit many species by satisfying varied needs for nesting, food gathering, and protection from predators. Intercropping systems using either legumes or trees, like those currently under study by Iowa State University's Leopold Center for Sustainable Agriculture (Best, 1990), hold much promise for improving cropland wildlife habitat.

In addition to a greater variety of crops, livestock are important on many diversified farms. Dairy cows, beef cattle, hogs, sheep, and goats provide m
nure for fertilizer, give the farmer a
other source of income, and offer a u
for legumes and grasses. Ruminants u
leguminous hay, which is needed to
nitrogen. Also, sheep and goats will e
weeds such as leafy spurge, thistle, a
knapweed, reducing the need for pes
cides (Leininger, ed., 1988).

There is no doubt that haying or ov
grazing of pastures and rangeland
livestock can be disastrous for wildl
and fish. Haying often occurs duri
prime nesting seasons (Farris et al., 197
Trautman, 1982; Warner and Ett
1989). Allowing livestock to use strea
banks and streams has ruined many
parian zones as habitat, and anim
wastes can pollute lakes and strea
However, if properly managed, livesto
can complement an environmental
sound farming scheme and, in so
cases, may even enhance wildlife habit

Continuous grazing of livestock c
be detrimental to many wildlife speci
However, a growing body of research i
dicates that controlled, rotational pa
turing, which is gaining popular
among sustainable farmers, often is b
ter than continuously grazed pastures
providing habitat for waterfowl, upla
birds, and big game species such as mu
deer and elk (Holechek et al., 1982; A
derson et al., 1990).

Wildlife ecologists differ on the su
ability of controlled grazing for wildli
Further study is needed, but grazing
likely to be more compatible with mo
birds' needs than haying. Some studi
suggest that controlled grazing schem
can improve habitat for some speci
such as sage and blue grouse and bo
white quail, even compared to no
grazed areas protected from livesto
(Hammerquist-Wilson and Crawfo
1981: Holechek et al., 1982). In o
North Dakota study, several nongam
species, including grasshopper sparro
and Baird's sparrow, seemed to pre
rotationally grazed pastures over idl
areas (Messmer, 1990). Several years
research on the Central Grasslands R
search Station in North Dakota ha
demonstrated that controlled grazi
can improve nesting success for so
waterfowl species (Barker et al., 19
Sedivec et al., 1990). The benefits

considered to result from enhanced food and cover, but grazing may also discourage predators, especially foxes (Bareiss et al., 1986; Sedivec et al., 1989).

National wildlife refuges move toward sustainable management

The wildlife management community generally has been slow to recognize sustainable agriculture's potential to enhance fish and wildlife habitat, but this is changing. The intense concern over biomagnification of DDT and other organochlorine insecticides prompted by Rachel Carson's *Silent Spring* died down after they were banned for most purposes in the United States. However, pesticide poisonings of wildlife again are receiving increased attention. The new awareness has resulted partly from recent research showing that current insecticides and application practices have devastating impacts on waterfowl and aquatic invertebrates (Grue et al., 1986; Grue et al., 1988; Tome and Grue, 1990a, 1990b).

A few national wildlife refuges began reducing chemical use and using integrated pest management and biocontrols in the late 1970s to enhance wildlife habitat. Two notable examples have been the Swan Lake Refuge in Missouri and DeSoto Refuge in Iowa, both in Fish and Wildlife Service (FWS) Region 3. For nearly a decade, Swan Lake reportedly was operating its farmland nearly organically, but is moving back toward conventional practices (Root, pers. commun., 1991). DeSoto is more committed than ever to adopting sustainable practices, an effort begun in 1979. Here, both groundwater pollution and wildlife have been the reasons. Insecticides are no longer used on the refuge, and herbicide and fertilizer use has been reduced considerably. Intensive public relations and training programs with refuge farmers have been important. Refuge staff are monitoring intensively to assess the environmental impacts of farm chemicals still being used (DeSoto National Wildlife Refuge, 1989, 1990).

In the mid-1980s, Region 6 of the FWS, including Kansas, North Dakota, Colorado, and Montana, began a serious push to cut chemical use and move toward alternative methods. Their efforts have been quite successful. Insecticide use has been almost eliminated on refuges in the region, and herbicide use was cut 63 percent between 1986 and 1990 (U.S. Fish and Wildlife Service, 1991). As with DeSoto, the refuges have stressed close cooperation with farmers, including training sessions, extra incentives, and field trips to organic farms.

FWS regions 3 and 6 are considered the leaders in developing and implementing sustainable procedures, but other regions, including Region 4 in the southeast, are expressing growing interest in this approach. National guidances to refuge personnel in 1985 and 1990 encouraged biological farming and integrated pest management on agency land. The most recent policy states that refuge managers' "ultimate goal is to eliminate pesticide use on Service lands and facilities where possible" (U.S. Fish and Wildlife Service, 1990). A more concerted effort to implement these policies is under way; and as part of this, pest management coordinators have been designated for all regions (Lyon, pers. commun. 1991).

Technical support for these efforts is now available from the Appropriate Technology Transfer for Rural Areas (ATTRA) project of the National Center for Appropriate technology in Fayetteville, Arkansas. Jurisdiction for ATTRA was transferred in 1990 to the Department of Interior from the Department of Agriculture. Two biologists have since been added to complement the program's information service with additional expertise on using sustainable farm and range management to enhance wildlife and fish habitat. Since this part of the program was initiated, staff have conducted workshops for wildlife professionals in the west, southwest, and southeast (Appropriate Technology Transfer for Rural Areas, 1990, 1991; Wilson, pers. commun., 1991).

Most wildlife inhabit private lands, not refuges; but the effort to adopt more environmentally sustainable farming practices on wildlife refuges is important for two reasons. First, it helps bring sustainable agriculture to the attention of the wildlife conservation community, a group that should be more closely allied with sustainable farmers and environmentalists in advocating farm policy reforms. Second, sustainable farming on refuges will help provide needed local models for producers and the public. Refuge farmers involved in developing and implementing sustainable practices in a supportive environment are learning about alternatives that many will use on their own lands and discuss with peers. This will aid the further adoption of no- or low-chemical practices.

Conclusion

Wildlife and fish habitat will be greatly enhanced if the movement toward more sustainable methods of farming becomes widespread. Reduced chemical use, more active soil stewardship, and a greater diversity of crops and livestock characterize this new approach. Such systems offer great advantages for birds, fish, and countless other creatures that dwell on land, in water, and in the soil.

The wildlife conservation community is just beginning to sense the potential of sustainable farming to help stem longtime declines of many wildlife and fish species in agricultural regions. Efforts to expand the use of alternative farming practices on wildlife refuges is an important step.

Gaining the interest and political support of millions of Americans who hunt, fish, birdwatch, and actively engage in other wildlife-related activities should be a concern of those advocating for sustainable agriculture. The perceived needs of wildlife and wildlife managers will not always coincide with those of sustainable farmers, but a great deal of common ground exists that often has been neglected. The two groups have much to share and much to gain from increased communication and cooperation.

References

1. Agricultural Law and Policy Institute. 1988. Farming and groundwater: An introduction. Issues Booklet No. 1. Minneapolis, Minnesota.

2. Albers, P. H. 1978. The effects of petroleum on different stages of incubation in bird eggs. Bulletin of Environmental Contaminants Toxicology 19:624-630.
3. Anderson, E. W., D. L. Franzen, and J. E. Melland. 1990. RX grazing to benefit watershed-wildlife-livestock. Rangelands 12(2):105-111.
4. Appropriate Technology Transfer for Rural Areas. 1990. ATTRAnews 1(1):1-4.
5. Appropriate Technology Transfer for Rural Areas. 1991. Wildlife meetings renew managers' interest in SA. ATTRAnews 1(3):1.
6. Balcomb, R. 1983. Secondary poisoning of red-shouldered hawks with carbofuran. Journal of Wildlife Management 47(4):1129-1132.
7. Balcomb, R. 1984. Toxicity of 16 granular insecticides to wild-caught songbirds. Bulletin of Environmental Contaminants Toxicology 33:302-307.
8. Bareiss, L. J., P. Schulz, and F. S. Guthery. 1986. Effects of short-duration and continuous grazing on bob-white and wild turkey nesting. Journal of Range Management 39(3):259-260.
9. Barker, R. J., and G. D. Waller. 1978. Sublethal effects of parathion, methyl parathion, or formulated methoprene fed to colonies of honey bees. Environmental Entomology 7(4):569-571.
10. Barker, W. T., K. K. Sedivec, T. A. Messmer, K. F. Higgins, and D. R. Hertel. 1990. Effects of specialized grazing systems on waterfowl production in southcentral North Dakota. In R. McCabe (ed.). Trans. North American Wildlife and Natural Resources Conf. 55:462-474.
11. Bennett, R. S., J. K. Bennett, S. M. Meyers, B. Marden, and A. Fairbrother. 1990. Effects of organophosphorus compounds on avian reproductive success. In Environmental Contaminants and Their Effects on Biota of the Northern Plains, Proc. North Dakota Wildlife Society symposium, Bismarck, North Dakota.
12. Benson, D., C. D. Baker, B. J. Forsyth, and J. S. Castrale. 1985. Herbicide (alachlor, atrazine, linuron and paraquat) residues in deer mice inhabiting conventional and minimum tillage row-crop fields. Indiana Academy of Science 94:373-380.
13. Berkman, H. E., and C. F. Rabeni. 1987. Effect of siltation on stream fish communities. Environmental Biology of Fishes 18(4):285-294.
14. Best, L. B. 1986. Conservation tillage: Ecological traps for nesting birds? Wildlife Society Bulletin 11:333-347.
15. Best, L. B. 1990. Sustaining wildlife in agroecosystems. Leopold Letter 2(4):4-7. Leopold Center for Sustainable Agriculture, Iowa State University, Ames, Iowa.
16. Blus, L. J., C. S. Staley, C. J. Henny, G. W. Pendleton, T. H. Craig, E. H. Craig, and D. K. Halford. 1989. Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. Journal of Wildlife Management 53(4):1139-1146.
17. Brewer, L. W., C. J. Driver, R. J. Kendall, C. Zenier, and T. E. Lacher. 1988. Effects of methyl parathion in ducks and duck broods. Environmental Toxicology and Chemistry 7:375-379.
18. Brewer, R. A. 1989. Disulfoton hazards to fish and wildlife: A synoptic review. Research Report, Institute of Wildlife and Environmental Toxicology, Clemson University, Clemson, South Carolina.
19. Bryan, G., and J. Pease. 1990. Agricultural pesticides and wildlife: A balancing act. Pamphlet, Iowa State University Extension, Ames, Iowa.
20. Buhl, K. J., and N. L. Faerber. 1990. Acute toxicity of selected herbicides and surfactants to larvae of the midge *Chironomus riparius*. In Environmental Contaminants and Their Effects on Biota of the Northern Plains, Proc. North Dakota Wildlife Society symposium, Bismarck, North Dakota.
21. Cacek, T. 1984. Organic farming: The other conservation farming system. Journal of Soil and Water Conservation 39(6):357-360.
22. Capel, P. D. 1990. Atmospheric deposition of herbicides in the mid-continental United States. EOS 17:1329.
23. Castrale, J. S. 1987. Pesticide use in no-till row-crop fields relative to wildlife. Indiana Academy of Science 96:215-222.
24. Clark, E. H., J. A. Haverkamp, and W. Chapman. 1985. Eroding Soils: The Off-Farm Impacts. The Conservation Foundation, Washington, DC.
25. Conover, M. 1987. Surface water quality impacts on aquatic systems in Iowa. In R. B. Dahlgren and E. E. Klaas (eds.). Proc. Management Alternatives for Biological Farming Workshop III. Iowa State University, Ames, Iowa. pp. 56-60.
26. Cox, R. L., and W. T. Wilson. 1984. Effects of Permethrin on the behavior of individually tagged honey bees, *Apis millifera* L. (Hymenoptera: Apidae). Environmental Entomology 13(2):375-378.
27. Dahlgren, R. B. 1967. The pheasant decline. South Dakota Dept. of Game, Fish and Parks, Pierre, South Dakota.
28. Dahlgren, R. B. 1984. Alternative Agriculture Systems: benefits to fish and wildlife resources. In Proc. Institute for Alternative Agriculture First Annual Scientific Symposium. Washington, DC. pp. 7-11.
29. DeSoto National Wildlife Refuge. 1989. Narrative report. Missouri Valley, Iowa.
30. DeSoto National Wildlife Refuge. 1990. Narrative report. Missouri Valley, Iowa.
31. Ducey, J., J. Rauscher, C. Wiederspan, L. Miller, A. Koehler, and D. Mazour. 1980. A biological comparison of organic and chemical farming. National Academy of Science student paper. Dept. of Forestry, Fisheries and Wildlife, University of Nebraska, Lincoln, Nebraska.
32. Duffy, M. D. 1991. Energy use and production practices on Iowa farms, 1989. Departmental paper. Dept. of Economics, Iowa State University, Ames, Iowa.
33. Edwards, C. A. 1965. Some side-effects from the use of persistent insecticides. Annals of Applied Biology 55:329-331.
34. Farris, A. L., E. D. Klonglan, and R. C. Nomsen. 1977. The ring-necked pheasant in Iowa. Iowa Conservation Commission, Des Moines, Iowa.
35. Finlayson, B. J., and G. A. Fagella. 1986. Comparison of laboratory and field observation of fish exposed to herbicides molinate and thiobencarb. Trans. of American Fisheries Society 115:882-890.
36. Flach, K. W. 1990. Low-input agriculture and soil conservation. Journal of Soil and Water Conservation 45(1):42-44.
37. Flickinger, E., K. King, W. Stout, and M. Mohn. 1980. Wildlife hazards from Furadan 3G applications to rice in Texas. Journal of Wildlife Management 44(1):190-196.
38. Forsyth, D. J. 1989. Agricultural chemi and prairie pothole wetlands: Meeting needs of the resource and the farmer - a C dian perspective. Trans. North Amer Wildlife and Natural Resources Conf. 54 66.
39. Freemark, K., B. Collins, C. Weseloh, Csizy, C. Rogers, W. Harris, A. Cyr, and Lepage. 1991. Comparative field study to e uate impacts of agricultural practices on b in Canada. Progress report. Canadian Wild Service, Ottawa, Ontario, Canada.
40. Galindo, J., R. J. Kendall, C. J. Driver, T. E. Lacher, Jr. 1984. The effects of me parathion on susceptibility of bobwhite q to domestic house cat predation. Behavi and Neurological Biology 43:21-36.
41. Goodman, L. R., D. J. Hansen, D. L. Copp J. C. Moore, and E. Mathews. 1979. Diazi Chronic toxicity to, and brain acetylcholi terase inhibition in, the sheepshead minn *Cyprinodon variegatus*. Trans. of Ameri Fisheries Society 108:479-488.
42. Graber, J. W., and R. R. Graber. 1983. declining grassland birds. Illinois Natural tory Survey No. 227. Champaign, Illinois.
43. Gremaud, G. K. 1983. Factors influenc bird use of rowcrop fields. M.S. thesis, D Animal Ecology, Iowa State University, A Iowa.
44. Grue, C. E., L. R. DeWeese, P. Mineau, G Swanson, J. R. Foster, P. M. Arnold, J. Huckins, P. J. Sheehan, W. K. Marshall, A. P. Ludden. 1986. Potential impacts of ricultural chemicals on waterfowl and o wildlife inhabiting prairie wetlands: An ev ation of research needs and approaches. Tr North American Wildlife and Natural sources Conf. 51:357-383.
45. Grue, C. E., M. W. Tome, G. A. Swans S. M. Borthwick, and L. R. DeWeese. 1 Agricultural chemicals and the quality of p rie-pothole wetlands for adult and juvenile terfowl - what are the concerns? In Proc. tional Symposium on Protection of Wetla from Agricultural Impacts. Colorado S University, Fort Collins, Colorado. pp. 55
46. Grue, C. E., L. R. DeWeese, G. A. Swan S. M. Borthwick, and C. M. Bunck. 1990. fects of aerial applications of 2,4-D, fenva ate, and ethyl and methyl parathion on wa fowl inhabiting prairie-pothole wetlands. Environmental Contaminants and Their fects on Biota of the Northern Plains, P North Dakota Wildlife Society symposi Bismarck, North Dakota.
47. Hammerquist-Wilson, M. M., and J. A. Cr ford. 1981. Response of bobwhites to c changes within three grazing systems. Jou of Range Management 34(3):213-215.
48. Henny, C. J., L. J. Blus, E. J. Kolbe, an E. Fitzner. 1985. Organophosphate insecti (famphur) topically applied to cattle kills pies and hawks. Journal of Wildlife Man ment 49(3):648-658.
49. Henny, C. J., and G. Herron. 1989. D selenium, mercury, and white-faced ibis re duction at Carson Lake, Nevada. Journa Wildlife Management 53(4):1032-1044.
50. Hoffman, D. J., J. C. Franson, O. H. Pa and C. M. Brunck. 1985. Survival, growth histopathological effects of paraquat inges in nestling American kestrels. Archives of vironmental Contamination and Toxico 14:495-500.
51. Holechek, J. L., R. Valdez, S. D. Schem

R. D. Pieper, and C. A. Davis. 1982. Manipulation of grazing to improve or maintain wildlife habitat. Wildlife Society Bull. 10(3):204-210.
52. Johansen, C. A. 1977. Pesticides and pollination. Annual Review of Entomology 22:177-192.
53. Kendall, R. J., R. Noblet, L. W. Brewer, M. J. Hooper, G. P. Cobb, and R. A. Brewer. 1990. Survivability, movement patterns and blood cholinesterase levels of wild northern bobwhites dosed with Counter. Research report, Institute of Wildlife and Environmental Toxicology, Clemson University, Clemson, South Carolina.
54. Kevan, P. G., A. Clark, and V. G. Thomas. 1990. Insect pollinators and sustainable agriculture. American Journal of Alternative Agriculture 5(1):13-22.
55. Klaas, E. E. 1982. Effects of pesticides on nontarget organisms. In R. B. Dahlgren (ed.). Proc. Midwest Agricultural Interfaces With Fish and Wildlife Resources Workshop. Iowa State University, Ames, Iowa. pp. 7-9.
56. Kumar, S., and S. C. Pant. 1984. Organal damage caused by Aldicarb to a freshwater teleost *Barbus conchonius* Hamilton. Bulletin of Environmental Contaminants Toxicology 33:50-55.
57. Leighton, F. A., and G. A. Wobeser. 1990. Occurrences of poisoning of wild birds. In Environmental Contaminants and Their Effects on Biota of the Northern Plains, Proc. North Dakota Wildlife Society symposium, Bismarck, North Dakota.
58. Leininger, W. C. (ed.). 1988. Non-chemical alternatives for managing selected plant species in the Western United States. U.S. Fish and Wildlife Service and Colorado State University Cooperative Extension, Fort Collins, Colorado.
59. Lenat, D. R. 1984. Agriculture and stream water quality: A biological evaluation of erosion control practices. Environmental Management 8(4):333-344.
60. Lyon, L. 1991. Personal communication, December 12. Biologist and National Pest Management Coordinator, Fish and Wildlife Service. Washington, DC.
61. Martin, P. A., and K. R. Solomon. 1990. Potential effects of carbofuran during the initial upland brood movement of mallard ducklings. In Environmental Contaminants and Their Effects on Biota of the Northern Plains, Proc. North Dakota Wildlife Society symposium, Bismarck, North Dakota.
62. Menzel, B. 1982. Farming impacts on fishery resources. In R. B. Dahlgren (ed.). Proc. Midwest Agricultural Interfaces with Fish and Wildlife Resources Workshop. Iowa State University, Ames, Iowa. pp. 27-29.
63. Messmer, T. A. 1990. Influence of grazing treatments on nongame birds and vegetation structure in southcentral North Dakota. Ph.D. dissertation. Dept. of Animal and Range Sciences, North Dakota State University, Fargo, North Dakota.
64. National Coalition Against the Misuse of Pesticides. 1991. Technical report 6(6):2.
65. National Research Council. 1989. Alternative Agriculture. Board on Agriculture. National Academy Press, Washington, DC.
66. Papendick, R. I., L. F. Elliott, and R. B. Dahlgren. 1986. Environmental consequences of modern production agriculture: How can alternative agriculture address these issues and concerns? American Journal of Alternative Agriculture 1(1):3-10.
67. Potts, G. R. 1985. Herbicides and the decline of the partridge: An international perspective. In British Crop Protection Conference--Weeds 983-990.
68. Rabb, G. B. 1990. Declining amphibian populations. Species: Newsletter of the Species Survival Commission, IUCN, World Conservation Union 13 & 14:33-34.
69. Rattner, B. A., and J. C. Franson. 1983. Methyl parathion and fenvalerate toxicity in American kestrels: Acute physiological responses and effects of cold. Canadian Journal of Physiological Pharmacology 62:787-792.
70. Root, T. 1991. Personal communication, June 14. Farming coordinator, DeSoto Bend National Wildlife Refuge, Missouri Valley, Iowa.
71. Sedivec, K., W. Barker, and P. Nyren. 1989. Effects of grazing systems on upland nesting waterfowl species in southcentral North Dakota. North Dakota State University. 1989 Grass and Beef Research Review. pp. 18-20.
72. Sedivec, K. K., T. A. Messmer, W. T. Barker, K. F. Higgins, and D. R. Hertel. 1990. Nesting success of upland nesting waterfowl and sharp-tailed grouse in specialized grazing systems in southcentral North Dakota. In Proc. of the Symposium Can Livestock Be Used as a Tool to Enhance Wildlife Habitat? 43rd Annual Meeting, Society for Range Management, Reno, Nevada.
73. Smith, P. W. 1971. Illinois streams: A classification based on their fishes and an analysis of factors responsible for disappearance of native species. Illinois Natural History Survey Biol. Notes 76. Champaign, Illinois.
74. Stickel, W. 1973. Effects on wildlife of newer pesticides and other pollutants. Proc. 53rd Annual Conference, Western Assoc. of State Game and Fish Commissioners, Salt Lake City, Utah. pp. 484-493.
75. Stinson, E. R., and P. T. Bromley. 1991. Pesticides and wildlife: A guide to reducing impacts on animals and their habitat. Virginia Dept. of Game and Inland Fisheries (Pub. 420-004), Blacksburg, Virginia.
76. Tome, M. W., and C. E. Grue. 1990a. Spray deposit in the wetland emergent zone following an aerial application of ethyl parathion to sunflowers in North Dakota. In Environmental Contaminants and Their Effects on Biota of the Northern Plains. Proc. North Dakota Wildlife Society symposium, Bismarck, North Dakota.
77. Tome, M. W., and C. E. Grue. 1990b. Effects of an aerial application of ethyl parathion on selected aquatic invertebrate populations inhabiting prairie pothole wetlands. In Environmental Contaminants and Their Effects on Biota of the Northern Plains, Proc. North Dakota Wildlife Society symposium, Bismarck, North Dakota.
78. Trautman, C. G. 1982. History, ecology and management of the ring-necked pheasant in South Dakota. South Dakota Dept. of Game, Fish and Parks, Pierre, South Dakota.
79. Turnbull, R., F. Johnson, M. Hernandez, W. Wheeler, and J. Toth. 1989. Pesticide residues in fulvous whistling-ducks from south Florida. Journal of Wildlife Management 53:1052-1057.
80. U.S. Environmental Protection Agency. 1989. Carbofuran: A special review technical support document. Office of Pesticides and Toxic Substances, Washington, DC.
81. U.S. Fish and Wildlife Service. 1989. Endangered species technical bulletin 14(1-2):1-7.
82. U.S. Fish and Wildlife Service. 1990. Administrative manual, pest management policy and responsibilities, release no. 30-5. Washington, DC.
83. U.S. Fish and Wildlife Service. 1991. Region 6 herbicide use report - 1980 through 1990. Refuges and Wildlife, Denver, Colorado.
84. Vance, D. R. 1976. Changes in land use and wildlife populations in southeastern Illinois. Illinois Wildlife Society Bulletin 4:121-136.
85. Virginia Dept. of Agriculture and Consumer Services. 1991. Board seeks emergency regulation against pesticide (news release May 10). Richmond, Virginia.
86. Ware, B. W., W. P. Cahill, P. G. Gerhardt, and J. M. Witt. 1970. Pesticide drift IV, on-target deposits. Journal of Economic Entomology 61:1982-1983.
87. Warner, R. E. 1991. Illinois farm programs: Long-term impacts on terrestrial ecosystems and wildlife-related recreation, tourism, and economic development. Report prepared for Illinois Dept. of Energy and Natural Resources, Research and Planning Division, Springfield, Illinois.
88. Warner, R. E., and S. L. Etter. 1989. Hay cutting and the survival of pheasants: A long-term perspective. Journal of Wildlife Management 53(2):455-461.
89. Way, M. J., and N. E. Scopes. 1965. Side effects of some soil-applied systemic insecticides. Annals of Applied Biology 55:340-341.
90. Wilson, R. 1991. Personal communication, July 10. Wildlife specialist, Appropriate Technology Transfer for Rural Areas, Fayetteville, Arkansas.

LETTERS TO THE EDITOR INVITED

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An economic comparison of conventional and reduced-chemical farming systems in Iowa

Craig Chase and Michael Duffy

Abstract. *Labor requirements, production costs, yields, and economic returns were evaluated for conventional and reduced-chemical cropping systems in northeast Iowa from 1978 to 1989. Continuous corn (C-C) and corn-soybean (C-Sb) rotations represented the conventional system; a corn-oat-meadow (C-O-M) rotation represented the reduced-chemical system. The C-C and C-Sb rotations used both commercial pesticides and fertilizers. The C-O-M rotation used manure for fertilization and applied pesticides only in emergencies. Operations for all systems were implemented by one farm manager. The C-Sb rotation had the highest corn yield over the 12-year period, and the C-O-M rotation the lowest. The corn within the C-O-M rotation, however, produced the second highest average return to land, labor, and management. With costs of production substantially lower than the conventional systems, the C-O-M corn crop had competitive returns despite lower yield. The C-Sb average return to land, labor, and management was significantly higher than for the other systems. Hourly labor charges of $4, $10, $20, and $50 had little effect on the rankings of economic returns. Because of unusually high alfalfa reseeding costs and low average oat yields, returns to the C-O-M rotation were significantly lower than C-Sb but comparable to C-C. With better alfalfa establishment and higher average oat yields, the reduced-chemical system might have been competitive with the C-Sb conventional system.*

Key words: conventional systems, reduced-chemical systems, agricultural profitability, economic returns, labor requirements, production cost comparisons

Introduction

Water quality problems associated with agriculture can be traced to farmer behavior (Moody, 1990). Over the past few decades, U.S. agriculture has replaced long-term crop rotations by monocultures or limited rotations. Technological advances in hybrids and mechanization, and introduction of synthetic fertilizers and pesticides, were the main forces behind this movement (Papendick, 1987). Herbicide carryover problems and government policies also favored limited use of rotations (Duffy and Chase, 1989; Libby, 1990; Young, 1989). In addition, farmers with only one or two crops in the rotation found management easier (Papendick, 1987).

Farming in monocultures or limited rotations increases reliance on chemicals to suppress pest populations. The reduction in the use of nitrogen-fixing legumes in long-term rotations has increased fertilizer rates (Papendick et al., 1986). The emphasis on monoculture or limited rotation row crops has increased soil erosion and reduced soil productivity. Further increases in fertilization are needed to compensate for the loss in productivity (Papendick, 1987).

Best management practices (BMPs) can reduce the need for pesticides and fertilizers, thus reducing potential ground and surface water quality problems (Voss et al., 1989). The main techniques for accomplishing this goal are cover crops, green manure crops, crop rotations, reduced tillage, manure management, and cultivation (Papendick et al., 1986). Crediting nitrogen from legumes and animal manure as well as using realistic yield goals based on soil productivity reduces potential nitrate contamination (Hallberg, 1987).

This does not mean that all farmers growing crops conventionally are creating environmental damage. Rather, our intent is to point out that alternatives exist that reduce the potential risk of environmental damage. However, the profitability of alternative, reduced-chemical systems is uncertain.

Crosson and Ostrov (1990) report that, in most cases, the profitability of alternative agricultural systems is lower than that of conventional systems. Reduced yields in alternative systems outweigh lower production costs. However, the authors state that economics may not be the most important obstacle to adoption of alternative agriculture. Other major obstacles include the managerial ability needed and the lack of information regarding implementation of practices.

Batie and Taylor (1989) are less convinced that alternative agriculture would be less profitable than conventional systems. They emphasize that the profitability of any system would be more a result of farm managerial skills than lower input costs. Higgs et al. (19 state that studies in Canada and

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United States have shown that profitable alternatives to continuous corn and corn-soybean rotations are available. The selection of individual crops in the rotation depends on the relation of product prices and production costs among the alternatives. Moreover, as environmental and soil erosion regulations and concerns increase, crop rotations including forages will be favored.

Madden and O'Connell (1990) cite an Illinois study indicating that net returns were higher for low-input farmers than high-input farmers despite lower gross returns. Careful management and lower input costs compensated for lower yields for the sample farms. Helmers et al. (1986) analyzed 13 different cropping systems for east-central Nebraska. The organic system, in which manure was charged at its application cost only, was economically competitive with most continuous cropping (one crop) and half-continuous cropping (two continuous crops) systems. Goldstein and Young (1987) found that their conventional system was economically advantageous over the low-input system only when government programs and high yields were assumed.

The northeast Iowa study began in 1978 to demonstrate two alternative systems. The C-C and C-Sb rotations represented the conventional system, using commercial pesticides and fertilizers. The C-O-M rotation using beef manure to meet fertilization needs represented the reduced-chemical system. This analysis compares the systems' labor requirements, production costs, yields, and economic returns from 1978 to 1989. We computed returns to land, labor, and management, and returns to land and management using various labor charges. Although manure is included in the reduced-chemical cropping system, no attempt was made to incorporate livestock into a whole-farm analysis.

Materials and methods

Study design

The study was conducted at the Northeast Research Center of Iowa State University, located southwest of Nashua, Iowa, in Floyd County. Three rotations were evaluated: continuous corn (C-C), corn-soybean (C-Sb), and corn-oat-meadow (C-O-M). The meadow was alfalfa hay established with oats as a companion crop. The meadow was harvested the following year. This is a common practice in Iowa. After the last alfalfa cutting in the production year, the alfalfa was torn up to be planted to corn. Each crop in each rotation was produced each year for 12 years. For example, the C-O-M rotation utilized three plots annually. This is in contrast to having a rotation located on one plot, with each crop in the C-O-M rotation harvested every three years; the increased number of observations allows for statistical analysis to be conducted with more confidence.

The C-C and C-Sb rotations were established as conventional systems using commercial pesticides and fertilizers. The C-O-M rotation was a reduced-chemical system using manure for fertilization and pesticides only when needed, based on pest populations as determined by the research farm manager.

The demonstration plots were not replicated. Each crop in the rotation was grown on half-acre plots. Three soil types comprised the entire plot area: Kenyon (fine-loamy, mixed, mesic Typic Hapludolls), Tripoli clay (fine-loamy, mixed, mesic Typic Haplaquolls), and Readlyn (fine-loamy, mixed, mesic Aquic Hapludolls). These soils are similar in that they are classified as mollisols formed in till deposited material, but they differ in their internal drainage and slope. Kenyon is moderately well-drained with a slope of 2-3 percent, Tripoli is poorly drained with 0-1 percent slope, and Readlyn is somewhat poorly drained with a 1-2 percent slope. The yield potentials per acre for the three soils range only from 152 to 157 bu for corn and 46 to 48 bu for soybean (Miller, 1987). Yield potentials are based on soil productivity characteristics. The uniformity of the soils should diminish the problem of non-replication.

Field operations and hours

Corn operations were identical in the conventional rotations except for a fall chisel plowing prior to corn planting in the C-C system (Table 1). The primary tillage implement in the C-O-M rotation was a moldboard plow rather than a chisel plow or field cultivator. The moldboard plow had the dual purpose of tearing up the alfalfa and incorporating the surface-applied manure. The manure was incorporated within 24 hours of application. Fall phosphorus (P) and potassium (K) and spring nitrogen (N) applications in the conventional system were replaced by fall application of beef

Table 1. Field operations, by rotation[1]

	C-C	C-Sb		C-O-M		
Operation	Corn	Corn	Sb	Corn	Oats	Mead.
Fall fertilize (P & K)	X	X				
Fall fertilize (manure)				X		
Fall moldboard plow				X		
Fall chisel plow	X		X		X	
Spring fertilize (N)	X	X				
Field cultivate/disk	X	X	2X	X	X	
Plant/drill	X	X		X	X	
Cultipack[2]					X	
Spray	X	X	2X			
Rotary hoe	X	X	X	X		
Cultivate	2X	2X	2X	2X		
Harvest[3]	X	X	X	X	X	X
Rake					X	
Bale hay/straw					X	X

[1] Operations varied among years. Operations listed are those typically performed.
[2] This implement consists of roller bars that compress soil over the oats and alfalfa seed to improve seed-to-soil contact.
[3] Corn, soybeans, and oats were harvested with a combine whereas alfalfa was harvested by a mower-conditioner. Raking and baling are listed as separate operations. Alfalfa was harvested 3 times per year.

manure in the reduced-chemical system. Pesticide applications were not made every year in the C-O-M rotation, but instead were based on pest populations. If the farm manager determined that damage to the crop would exceed the cost of application, including materials and machinery costs, the pesticide was applied. Pesticide applications were made in 1986-1988. Post-emergent mechanical weed control using one rotary hoeing and two cultivations was common to all systems.

The soybean crop followed a similar weed-management program with rotary hoeing, cultivations, and herbicides. Alfalfa was seeded with the oats crop. Additional seedings were necessary in 6 of the 12 years because of poor establishment. Reestablishment was necessary in 1984 and 1989 following the drought years of 1983 and 1988, and in 1980, 1981, and 1982 primarily because of low pH and fertilization levels. These additional seedings adversely affected economic returns, as will be discussed in the summary section. The choice and timing of all cultural practices were left to the research farm manager.

The conventional rotations are similar in amount of fieldwork (Table 2). Of all corn crops, the corn in the C-O-M rotation required the most labor because of the manure application. The labor for the manure applications is estimated at .8 hours per acre using procedures recommended by Melvin (1979). Total hours per acre for all corn operations in C-O-M was 2.2 using engineering estimates by Ayers and Williams (1986). The oats and alfalfa took 1.1 and 1.5 hours per acre. The average for the C-O-M rotation was 1.6 hours per acre, the highest figure among rotations.

Table 2. Estimated fieldwork, by crop and rotation, 1978–1989[1]

Rotation/Crop	Fieldwork (hr/A)
Continuous corn	
corn	1.4
Corn-soybean	
corn	1.3
soybeans	1.3
average	1.3
Corn-oat-meadow	
corn	2.2
oats	1.1
meadow	1.5
average	1.6

[1] Based on Ayers and Williams (1986) and Melvin (1979).

Fertilizer and pesticide programs

Phosphorus and potassium were applied to corn annually in the C-C rotation at a rate of 0-60-60 during 1978-1983. The rate was adjusted to 0-40-80 for the period 1984-1989. The corn in the C-Sb rotation received 0-120-120 through 1983, 0-60-80 in 1984, and 0-80-160 for the 1985-1989 period. P and K applications were established and modified according to soil test results. Additionally, 75 lb of 5-20-20 starter fertilizer was applied annually to the corn at planting for both conventional rotations. Nitrogen application rates varied slightly among years: 140-150 lb/A annually for the rotated corn (C-Sb) and 175-180 lb/A for C-C. No fertilizer was applied to any crop other than corn, regardless of the system. Manure was applied before corn in C-O-M at 8 ton/A during 1978-1980, 10 ton/A during 1981 and 1982, and 20 ton/A each year from 1983 to 1989. Manure applications also were modified according to soil test results. Lime was applied at 3.5 ton/A to all plots in the fall of 1982, after harvest.

At planting, C-C received an annual corn rootworm insecticide application of slightly over 1 lb/A active ingredient (a.i.). In addition, slightly over 4.5 lb/A a.i. of herbicides were applied annually. On average, the C-Sb rotation received approximately 3 lb/A a.i. of herbicides annually. Herbicide and insecticide applications for the conventional rotations were made regardless of pest populations. Insecticides were used only once in the C-O-M rotation (.8 lb/A a.i. on alfalfa). Corn in C-O-M received emergency herbicide treatment (.5 lb/A) in 3 of the 12 study years. Perennial weeds such as Canada thistle and quackgrass have been particularly troublesome in the C-O-M rotation.

Results

Production costs

Machinery and input cost of produ
tion were determined by applying stan
ardized cost estimates to the cultur
practices in each rotation using Duf
(1990 and previous years). This public
tion is updated and revised yearly. T
standardization of costs per operati
eliminates differences from purchasi
discounts of inputs and machinery r
pairs and depreciation, among othe
and allows the focus to be on practic
Herbicide and insecticide price data we
obtained from unpublished price lis
The manure application in the C-O-
system was calculated at the cost of a
plication only. No charge was assess
for the value of the manure.

Production costs by crop and rotati
are presented in Table 3. Total produ
tion costs for the corn in the conve
tional rotations are similar ($207 for
C versus $190 for C-Sb). Chemical co
of the C-Sb rotation were $6/A low
than the C-C rotation because a roo
worm insecticide was not used. Oth
expenses were similar because simil
practices were used. Machinery expens
were slightly lower for corn in the C-
M rotation. Seed, fertilizer, and chemi
costs, however, were $76 and $60/
lower for the C-O-M rotation than the
C and C-Sb rotations, respectively. To
production costs for the C-O-M rotati
were approximately $100/A lower th
for the C-C and $75/A lower than t
C-Sb rotations.

Average production costs for the
Sb rotation were $48/A lower than
the C-C system ($159 versus $20
Lower fertilization, machinery, a
chemical costs for the C-Sb soybean cr
contributed to this result. Because it h
essentially no chemical costs, less th
one-half the seed and fertilizer costs, a
lower machinery and miscellaneo
costs, the C-O-M system was operat
at one-half the production cost of C-
The cost of seeding the alfalfa crop
included with the oats, seed, and fe
lizer costs. The cost of reseeding alfa
in 6 of the 12 years averaged $27/A a
is included under the meadow colum

Yields

Two yield analyses were completed during this study. First, average treatment yields for the 12-year period were tested for statistical significance using analysis of variance (ANOVA). Following determination of significance, Tukey's multiple range test (HSD) was used for testing statistical differences among individual crops. Second, a simple linear regression analysis was used to determine if there were any long-term trends.

Average yields by crop and rotation are reported in Table 4. All crops were grown every year; thus the averages cover the entire 12-year period. The C-Sb average corn yield of 137 bu/A was significantly higher than C-C average corn yield of 118 bu/A, which is typical for Iowa. The C-O-M rotation corn yield was significantly lower than yields of the other rotations. This result is surprising, since the yield of first-year corn following alfalfa should be fairly close to that of a C-Sb rotation (Voss and Shrader, 1984). There were two main reasons. First, unlike the Voss and Shrader experiments, this comparison is between a conventional system and reduced-chemical system. The reduced-chemical system used only animal manure to supply all nutrients. It was determined following the 1982 crop that nutrient levels were insufficient with an application rate of 8 ton/A. Second, 1983, 1988, and 1989 were dry years. The corn following alfalfa for those three years averaged 25-30 bu/A lower than the conventional systems. Available water was not adequate to replace the amount used by the previous alfalfa crop.

We computed regressions of yield on time for corn, by rotation. None of the estimated coefficients for time was significant, and thus none will be presented.

Soybean yields remained relatively stable while oat yields increased substantially since 1984. Oat yield averaged 81 bu/A from 1984 to 1989 compared to 42 bu/A from 1978 to 1983. Alfalfa yield has suffered from poor establishment. Reasons for reseeding were discussed earlier.

Table 3. Annual production costs ($/A), by crop and rotation, 1978–1989[1]

Rotation/crop	Corn	Soybeans	Crop Oats	Meadow	Average[2]
Continuous corn					
Machinery-fixed	46				46
Machinery-variable	35				35
Seed and fertilizer	74				74
Chemicals	28				28
Miscellaneous	24				24
Total	207				207
Corn-soybean					
Machinery-fixed	46	33			40
Machinery-variable	36	17			27
Seed and fertilizer	64	39			52
Chemicals	22	19			21
Miscellaneous	22	19			21
Total	190	127			159
Corn-oats-meadow					
Machinery-fixed	44		30	27	34
Machinery-variable	31		18	17	22
Seed and fertilizer	23		41	27	30
Chemicals	3		0	0	1
Miscellaneous	14		6	6	9
Total	115		95	77	96

[1] Corn machinery expenses include field operations, drying, handling, and hauling. Machinery expenses for all other crops include field operations, handling and hauling. Land and labor costs are not included.
[2] Totals are rounded to the nearest dollar.

Returns

The analysis of returns has two parts: first, an analysis of returns to land, labor, and management; second, an analysis conducted with a labor charge subtracted to estimate a return to land and management. Land charges are not considered in this study. Thus, this study assumes debt charges, equity charges, real estate taxes, and other land ownership costs would not be affected by the rotation system selected.

Farm labor is typically provided by the owner/operator. The value associated with this labor will depend upon the types of enterprises and operations involved, outside opportunities available, and other variables. Therefore, we

Table 4. Yields by crop and rotation, 1978–1989

Rotation	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Avg.[1] 1978–89
C-C													
	87	130	129	145	121	99	108	104	179	140	77	95	118 b
C-Sb													
Corn	134	171	153	158	134	87	123	130	187	157	95	110	137 a
Soybeans	40	42	34	26	32	43	33	29	47	45	28	35	36
C-O-M													
Corn	45	145	111	112	67	32	99	113	141	118	92	72	95 c
Oats	53	23	53	50	33	39	70	98	80	68	74	94	61
Meadow	4.2	4.2	3.4	1.7	1.6	1.6	2.3	3.8	5.0	2.8	2.5	.9	2.8

[1] Corn yields followed by the same letter are not significantly different at p = 0.05. Alfalfa yields are in ton/A, all others are bu/A.

present results with no labor charge and four alternative labor charges ($4, $10, $20, and $50 per hour). Operations for both systems and three rotations were implemented by one farm manager. We assume there are no differences among systems and rotations in managerial ability required.

Yearly average Iowa corn, soybean, oats, and alfalfa prices received by farmers, as well as the cost assumptions outlined previously, were used in the returns analysis. Farm commodity prices varied by year but averaged $2.34/bu for corn, $6.21/bu for soybeans, $1.68/bu for oats, and $58.05/ton for alfalfa. Oat straw yields also varied by year, averaging .6 ton/A. Oat straw was assumed to be sold off-farm at an average price of $35/ton. Gross revenues were calculated by multiplying annual commodity prices by annual yields.

Economic returns were calculated by subtracting production costs from gross revenues on a yearly basis. The annual returns were then averaged, with differences tested for statistical significance through an ANOVA procedure. Because returns were first calculated on an annual basis prior to statistical analysis, the variability among years was not lost. Following determination of overall significance, Tukey's multiple range test (HSD) was used for testing statistical differences among individual treatments.

Returns to land, labor, and management

Average returns to land, labor, and management for each system are presented in Table 5. Returns for corn within the C-Sb and C-O-M rotations were not significantly different at $125/A and $105/A, respectively. Both returns were significantly higher than the return for C-C ($67/A).

Analysis of the returns to the rotations over 12 years revealed that the C-Sb rotation received the highest average return ($110/A), which is significantly higher than returns of the other rotations. The returns to the C-C and C-O-M rotations were not significantly different at $67/A and $69/A, respectively.

Table 5. Returns to land, labor, and management ($/A), by crop and rotation, 1978–1989[1]

Rotation	Corn	Soybeans	Oats	Meadow	Avera
C-C	67 b	—	—	—	67 b
C-Sb	125 a	95	—	—	110 a
C-O-M	105 a	—	28	74	69 b

[1] Returns within columns followed by the same letter are not significantly different at p = 0.05.

Returns to land and management

This section presents returns to land and management, with varying labor charges. As discussed previously, the proper labor charge for the farm owner/operator can only be determined individually, because of the wide variability in opportunity costs for labor. Hourly rates of $4, $10, $20, and $50 were chosen to cover the range for Iowa farmers. Returns to land and management are presented in Table 6. With a labor charge of $4/hr, the C-Sb rotation produced the highest average return for corn, at $119/A. The C-Sb corn returns were not significantly higher than those of the C-O-M. This was also true for labor at $10/hr. Increasing the labor charge to $20/hr lowered the C-O-M corn return significantly below the average C-Sb return.

For the rotational average with a $4-per-hour labor charge, the C-Sb rotation also resulted in the highest average return. C-C and C-O-M average returns for both rotations were significantly lower, at $61/A and $63/A, respectively. These relations held through the range of labor costs used.

Discussion

Three limitations of the study shoul be noted. First, any system is only a good as the farmer. That is, how success fully farmers apply managerial ability t a system significantly affects economi returns. In this study, the reduced-chem ical system, which included evaluation of pest populations, diverse crops, an animal manures, was more complicate to manage. Second, this study does no take into consideration the influence o any government program. We know tha the farm program affects the choice o rotation. However, long-range plannin should not be based on a program tha may change drastically over the next 5 t 10 years. Third, the lack of replications i a significant limitation, but the uniform ity of soils throughout the plot area low ers possible biases from non-replication

Bearing these limitations in mind, sev eral conclusions can be drawn from thi study. For corn, the C-O-M rotatio produced competitive returns to land, la bor, and management. Reducing the cos of production by $75/A allowed the C O-M corn to be competitive with the C

Table 6. Returns to land and management ($/A) for various labor charges, by crop and rotation, 1978 1989[1]

Rotation	Labor Charge per hour			
	$4	$10	$20	$50
Corn				
C-C	61 b	53 b	39 b	−4
C-Sb	119 a	111 a	98 a	59
C-O-M	96 a	83 a,b	61 b	−3
Rotational average				
C-C	61 b	53 b	39 b	−3
C-Sb	104 a	97 a	84 a	44
C-O-M	63 b	53 b	37 b	−10

[1] Returns within columns followed by the same letter are not significantly different at p = 0.05.

Sb corn, despite significantly lower yields. This reduction in costs also removed the 23 bu/A advantage of C-C over C-O-M. Thus, crops within cropping systems with lower yields can produce competitive returns.

When all the crops in the system are included, the C-O-M rotation was no longer competitive with the C-Sb rotation. The returns to land, labor, and management for oats and meadow ($28/A and $74/A, respectively) lowered average returns by $36/A. Alfalfa production costs influenced these results. Reseeding costs were $27/A (for seed only) plus additional drilling and preparation costs. Other studies in Iowa have shown that alfalfa can be grown for only one year successfully. Insufficient nutrients and dry conditions hindered alfalfa establishment in some years of the study. Moreover, oat yields in the latter half of the study almost doubled over those achieved in the first 6 years. Successful oat and alfalfa crops therefore are possible in Iowa and if maintained can have competitive economic returns.

Increasing the labor charges from $4/hr to $50/hr did not affect the rankings of the rotations' returns. The additional .2 to .3 hr/A labor requirement for the C-O-M rotation does not significantly affect its lower production cost advantages.

In summary, it is imperative to analyze the entire system. Evaluating only one component or crop may lead to inappropriate conclusions. Including only corn in the analyses, one forgets the importance of focusing managerial abilities on all crops within the system. That is, it loses the effect of poor alfalfa establishment on both the alfalfa and following corn crop or low oat yield. Moreover, when dealing with crops and livestock, the cropping system should be regarded as only part of the farming system. The ability to utilize manure for the cropping system and feedstuffs (oats and alfalfa) for the livestock system has definite value. Farmers must carefully evaluate their alternative farming system strategies. This study shows that a reduced-chemical system can be economically competitive with a C-C conventional system. Given better alfalfa establishment results, the reduced-chemical system tested could have been competitive with a C-Sb conventional system.

References

1. Ayers, G., and D. Williams. 1986. Estimating field capacity of farm machines. Bulletin PM-696. Cooperative Extension Service, Iowa State University, Ames, Iowa.
2. Batie, S., and D. Taylor. 1989. Widespread adoption of non-conventional agriculture: Profitability and impacts. American Journal of Alternative Agriculture 4:128-134.
3. Crosson, P., and J. Ostrov. 1990. Sorting out the environmental benefits of alternative agriculture. Journal of Soil and Water Conservation 45:34-41.
4. Duffy, M. 1990 and previous issues. Estimated costs of crop production in Iowa. Bulletin FM-1712. Cooperative Extension Service, Iowa State University, Ames, Iowa.
5. Duffy, M., and C. Chase. 1989. Impacts of the 1985 Food Security Act on crop rotations and fertilizer use. Department of Economics, Iowa State University, Ames, Iowa.
6. Goldstein, W., and D. Young. 1987. An agronomic and economic comparison of a conventional and a low-input cropping system in the Palouse. American Journal of Alternative Agriculture 2:51-56.
7. Hallberg, G. 1987. Agricultural chemicals in ground water: Extent and implications. American Journal of Alternative Agriculture 2:3-15.
8. Helmers, G., M. Langemeier, and J. Atwood. 1986. An economic analysis of alternative cropping systems for east-central Nebraska. American Journal of Alternative Agriculture 1:153-158.
9. Higgs, R., A. Peterson, and W. Paulson. 1990. Crop rotations: Sustainable and profitable. Journal of Soil and Water Conservation 45:68-70.
10. Libby, L. 1990. A public policy perspective on groundwater quality. Journal of Soil and Water Conservation 45:190-193.
11. Madden, J., and P. O'Connell. 1990. LISA: Some early results. Journal of Soil and Water Conservation 45:61-64.
12. Melvin, S. 1979. Land disposal systems for animal waste. Paper No. MC-79-105. Presented at the American Society of Agricultural Engineers Mid-Central meeting, St. Joseph, Missouri.
13. Miller, G. 1987. Establishing realistic yield goals. Bulletin PM-1268. Cooperative Extension Service, Iowa State University, Ames, Iowa.
14. Moody, D. 1990. Groundwater contamination in the United States. Journal of Soil and Water Conservation 45:170-179.
15. Papendick, R. 1987. Why consider alternative production systems? American Journal of Alternative Agriculture 2:83-86.
16. Papendick, R., L. Elliott, and R. Dahlgren. 1986. Environmental consequences of modern production agriculture: How can alternative agriculture address these issues and concerns? American Journal of Alternative Agriculture 1:3-10.
17. Voss, R., and W. Shrader. 1984. Crop rotations: Effect on yields and response to nitrogen. Bulletin PM-905. Cooperative Extension Service, Iowa State University, Ames, Iowa.
18. Voss, R., R. Killorn, M. Amemiya, R. Fawcett, D. Grundman, H. Stockdale, S. Melvin, M. Duffy, and G. Benson. 1989. Best management practices to improve groundwater quality in Iowa. Cooperative Extension Service, Iowa State University, Ames, Iowa.
19. Young, D. 1989. Policy barriers to sustainable agriculture. American Journal of Alternative Agriculture 4:135-143.

Two Requests for Research Grant Proposals Are Issued

The USDA-EPA's "Agriculture in Concert With The Environment" program, and the Center for Field Research at Earthwatch are requesting research grant proposals. The USDA-EPA program seeks proposed research projects that will estimate the farm-level effects of moving toward a more sustainable agriculture for a particular region in the United States. A total of $750,000 is available for funding up to six regional projects over three fiscal years (1992-1994). Contact Greg Gajewski, Coordinator, Sustainable Agriculture Economic Impact Study, USDA-Economic Research Service, Room 1208, 1301 New York Ave., NW, Washington, D.C. 20005-4788; (202) 219-0888.

The Center for Field Research invites proposals for field research in sustainable agriculture worldwide, particularly projects which address the environmental, social, and economic dimensions of sustainable agricultural systems. Field grants average $25,000. Contact Program Officer Catherine J. Schlager at the Center, 680 Mt. Auburn Street, Box 403, Watertown, MA 02272; (617) 926-8200; FAX: (617) 926-8532.

Marketing prospects for organic and pesticide-free produce

Desmond A. Jolly and Kim Norris

Abstract. *The March 1989 food safety episodes involving Alar on apples and the cyanide tainted grapes found in a Chilean shipment were seminal events in the history of U.S. organic agriculture. Demand for organic produce soared as a consequence of these events, and mainstream supermarkets began adding more organic produce to their traditional product lines. But when organic supplies proved scarce, and as prices increased, consumer purchases decreased and many marketing managers began to question the rationality of allocating scarce shelf space to organic products. In fact, many supermarket chains either drastically reduced their organic offerings or dropped them altogether. Some analysts proclaimed that organics had failed the market test. However, two surveys we carried out in 1989 and 1991 among major California supermarket chains show that forecasts of the demise of organic produce in mainstream markets may have been premature. Of 16 chains responding to our survey, 12 continue to carry organic produce. All had carried organics for more than six months, two-thirds of them for more than a year. Of the 12 that carry organics, six rate organics as worse overall than conventional produce. But, interestingly, six rate organics as "about the same" as conventional produce. This is a significant achievement for organics. Organics rated better on environmental impact and residues, worse on appearance and shelf life, and "about the same" on flavor and nutritive value. Despite the constraints and difficulties encountered in marketing organic foods, 8 of the 12 chains that carry organics would carry more organic fruits and vegetables if supplies were available. The prospects for certified "pesticide free" produce are less definite.*

Key words: organic marketing, pesticide-free produce

Introduction

Following the food safety episodes involving Alar and grapes in the spring of 1989, the demand for organic produce soared. *Time* magazine, in a cover article entitled "Is Anything Safe: How Two Tainted Grapes Triggered a Panic About What We Eat," captured the essence of consumer and retailers' reactions to concerns about the short- and long-term risks associated with food safety. Among the many consequences were that Chilean fruit was embargoed by the U.S., Japan, and Canada. According to the *Time* article (March 17, 1989), 20,000 Chilean food workers were fired and an additional 200,000 jobs were put at risk.

In the wake of the Alar incident, U.S. apple consumption declined precipitously and the U.S. apple industry appeared economically endangered. In "Dining With Invisible Danger" (Toufexis, 1989), *Time* surveyed the then current state of the food safety environment. The article began with a nod to nostalgia: "Remember the good old days when Americans did not know too much about what they were eating and drinking. People would nod approvingly as they pushed their carts through supermarkets. The fruits and vegetables were piled high in glistening mounds, the pristine boxes and shiny cans crammed on shelves, the chickens sitting plumply in refrigerated cases, and the fish shimmering on crystalline beds of ice. The entire scene seemed drenched in wholesomeness." The article then contrasted this romanticized wholesome past with the 1989 food safety environment:

Last week's panics over poisoned grapes and tainted apples were merely the latest in a relentless series of food scares. Anyone who reads newspapers or watches TV knows that invisible dangers lurk in every aisle of the grocery store. Shoppers have been told that the produce is peppered with pesticide, the boxes and cans packed with treacherous additives, the meat stuffed with powerful drugs, the chicken spattered with bacteria, and the fish steeped in chemical wastes. Even the cool clear water that comes out of every kitchen tap is suspected of being a witch's brew laced with lead, microorganisms and industrial pollutants. To many people, eating and drinking have become death-defying feats. No wonder sales of "organic foods" and bottled waters have surged to new heights. (Toufexis, 1989).

Indeed, organic food demand increased sharply, so much so that it created severe shortages and bottlenecks as retailers scrambled for supplies. Prices reflected the increased demand and inelastic supply. The organic production-distribution system came under tremendous pressure to meet demand, to fulfill customer commitments, to maintain product quality, and to meet consumer expectations for prices and quality.

For several reasons, this temporary boom proved unsustainable. Consumer food safety fears diminished with time and the willingness to pay organic premiums decreased accordingly. As a result retailer margins could not be sustained

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and many conventional supermarkets that had introduced an organic product line withdrew from the market. The situation was summarized this way in the popular press: "This is the first real test of organic farming's staying power, coming one year and one growing season after Chilean grapes and Alar-treated apples shocked the public into greater food safety awareness. And, so far, organic is failing that test, retail experts say." (La Ganga, 1990). The article identified several retail chains that had substantially reduced or discontinued their organic lines. The market situation and outlook for organics looked bleak.

Purpose and methods

To go beyond anecdotal accounts of market situation and prospects, we did two surveys of California retail chains. In the fall of 1989 and again in winter 1991, surveys were mailed to the central offices of all 37 supermarket chains in California. Chains were defined as retail food marketing firms with 10 or more stores, and the 37 chains operating in California were identified using *The Red Book* by Vance Publishing.

The survey questionnaire was directed to produce or marketing managers and was intended to learn the following: whether any of the chains' stores carry organic produce; the locations of those stores; managers' perceptions of organics and their perceptions of customer assessments of the quality of organic and conventional produce; and their evaluations of marketing problems associated with organics. They also were asked to identify changes that would let them market organics more successfully.

Key factors that affect the environment in which food production-delivery systems operate include consumer demand and public and institutional policies. This paper focuses on chain-store supermarkets as a key institution in the organic food chain. In fact, organically produced foods have depended on an alternate food chain involving organic distributors and health food stores, as well as farmers markets and consumer cooperatives. But increased penetration of mainstream food markets would enhance the economic viability of organics and exert more influence on conventional food production systems.

The paper also addresses how policy changes may affect the performance of the marketing system for organics. The policies we discuss focus on the supply of information to key decision-makers in the system, including growers, wholesalers, retailers, and consumers. We examine whether recent changes in legislation and regulation would tend to enhance or retard growth in the market for organics.

Results

Characteristics of stores surveyed

Of the 37 California supermarket chains surveyed, 16 returned valid, completed surveys, a response rate of nearly 50 percent. These 16 respondents represent a total of 1,405 stores. Table 1 shows the distribution of chains by number of stores. Just 5 chains, each with more than 100 stores, accounted for 72 percent of all stores. Sixty percent of the stores were located in the suburbs; 36 percent in the central cities. Almost half the stores were in southern California (Table 2). About half the chains had average sales of over $15 million per store per year (Table 3).

Table 1. Distribution of Chains by Number of Stores

Number of Stores in Chain	Number of Chains	Percent of total stores represented in the sample
1 to 9	2	0.9
10 to 19	3	3.4
20 to 39	2	3.3
40 to 99	4	19.7
100 to 350	5	72.4

Table 2. Geographic Distribution of Stores

	No. stores	Percent of total
Central Valley (area codes 916, 209, 805)	307	22%
North Coast (area codes 415, 408, 707)	432	31%
South State (all other area codes)	666	47%

Table 3. Distribution by Average Annual Sales

Average Annual Sales per Store	No. Chains
Below $5 million	0
$5 to $9.99 million	2
$10 to $14.99 million	6
$15 to $19.99 million	2
$20 million and above	5
No response	1

Marketing organics: Trends and perceptions

All respondents indicated familiarity with California's health and safety code 26569.11, which sets forth definitions of organically grown products. This contrasts with the 71 percent that responded affirmatively to this question in the 1989 survey. Table 4 shows that 12 chains carry organic products, compared with only 6 that carry certified "pesticide free" produce. There is an overlap, however, in that all of the stores that carry certified "pesticide free" produce also carry organics. Possibly these chains have positioned themselves as health and safety oriented food marketing systems.

In the 12 chains that carry organics, 699 of their 1124 stores carry organics. All these chains have carried organics for more than 6 months, and two-thirds for more than a year. None of our respondents had entered the organic business within the prior 6 months. Most of their current activity involved market adjustments for particular items (Table 5). Fresh fruit and vegetables are the

Table 4. Number of Chains Whose Stores Carry:

	No. chains	Percent of chains
Certified "pesticide free"	6	38%
Organically grown foods	12	75%
"Natural" foods	13	81%

Table 5. Changes Made in Organic Food Lines

Activity	Number of Chains
Added some organic items:	7
Discontinued some organic items:	9
Increased some organic lines:	3
Cut back some organic lines:	6

dominant organic product lines by number of chains and sales volume (Table 6).

Merchandiser perceptions

Of those chains that carry organics, produce managers were asked to compare organic and conventional products. Half the respondents thought that, overall, organics were about the same as conventional, and half perceived organics as worse than their conventional counterparts. In our 1989 survey, 8 of 12 rated organics as worse overall than conventional. Eleven of the 12 respondents rated organics as worse in appearance, and 9 out of 12 rated them worse in shelf life. Table 7 summarizes their responses.

Organics fared significantly better in other attributes: residues, environmental impact, flavor, and nutritive value. For the perceived levels of chemical residues, 8 of 12 respondents rated organics as 'better,' 3 'about the same,' and 1 'don't know.' On environmental impact, 5 respondents perceived organics as 'better,' 5 as 'about the same.' On flavor and nutritive value, organics were rated as approximately equal to conventional.

Merchandiser perceptions of consumer attitudes towards organics

When the merchandisers were asked for their perceptions of how their consumers would rate organics versus conventionally produced products (Table 8), organics rated 'better' in chemical residues and environmental impact, 'better' to 'about the same' in nutritive value, and 'about the same' in flavor. Again, on shelf life and flavor, organics were perceived as at a disadvantage. Interestingly, only one of our respondents gave an overall 'better' rating to organics, while 6 rated organics as 'worse' and 3 as 'about the same.' On the individual attributes, however, organics are rated very highly with respect to chemical residues, environmental impacts, nutritive value, and flavor.

Marketing difficulties and constraints

There are significant production constraints in organic systems that affect the marketing system for organics, especially regarding supply, availability, and prices. Respondents were asked to identify, from a list of possible constraints, those they considered most significant for their operations. They identified the most important problems as availability, quality, prices, lack of standards, insufficient shelf space, and weak coordination of the distribution system (Table 9).

Table 6. Types of Organic Products Carried by Chains and Ranking by Sales

Organic Food Category	Number of Chains that Carry	Top Three Categories by Sales Volume
Fresh vegetables	12	1
Fresh fruit	12	2
Juices	4	3
Herbs and spices	6	
Dried fruit	3	

Table 7. Buyer/Merchandiser Attitudes Toward Organic vs Conventionally Grown Products

	Organic is better	Organic is worse	About the same	Don't know
In general	0	6	6	0
Appearance	0	11	1	0
Shelf life	1	9	2	0
Chemical residue	8	0	3	1
Environmental impact	5	0	5	2
Flavor	0	1	11	0
Nutritive value	0	0	12	0

Table 8. Perceived Customer Attitudes Toward Organically Grown Foods

	Organic is better	Organic is worse	About the same	Don't know
In general	1	6	3	2
Appearance	0	11	1	0
Shelf life	0	7	3	2
Chemical residue	11	0	0	1
Environmental impact	10	0	0	2
Flavor	1	1	9	1
Nutritive value	6	0	5	1

Table 9. Difficulties Encountered by Stores Carrying Organically Grown Foods

	Yes	No	Top Three Difficulties
Supplies are not always available when needed	12	0	#1
Poor quality	11	1	#2
Prices are too high	9	3	#3
Lack of standards/grading	9	3	#3
Insufficient shelf space	9	3	#3
Distribution system not coordinated	8	4	
Not enough volume to justify the effort	8	4	

However, prices dropped from the number one problem in 1989 to number three in 1991. This may presage potentially greater market penetration for organics as their prices become more competitive with conventional produce. For stores that do not carry organics, the perceived constraints are generally the same as for stores that do: availability, prices, insufficient demand, and quality concerns (Table 10).

Table 10. Constraints Keeping Stores From Carrying Organically Grown Foods

	Yes	No
Supplies are not always available when needed	2	0
Prices are too high	3	0
Insufficient demand	2	0
Poor quality	1	1
Lack of standards/grading	1	0
Distribution system not coordinated	2	0
Not enough volume to justify the effort	2	0
Insufficient shelf space	3	0

Demand prospects

Two-thirds of the respondents indicated that they would carry more fresh fruits and vegetables if supplies were available; 4 would carry more herbs and spices; but only 1 would offer more cereals and grains, meats, eggs, and poultry (Table 11). With respect to the kinds of improvements that would encourage stores not now carrying organic products to do so, they indicated increased customer demand, improved quality, and lower prices. Two of the chains that do not now carry organics did so in the past although for less than six months. Their discontinuance of the organic line had to do with availability, prices, and insufficient customer demand.

Table 11. Would Carry More If Supply Were Reliable

	Yes	No	Don't Know
Fresh fruits and vegetables	8	4	0
Herbs and spices	4	2	2
Cereals and grains	1	1	4
Meat products	1	1	4
Eggs and poultry	1	1	4

Certified 'pesticide free' produce

At one point, certified 'pesticide free' produce was perceived by some of its advocates as competitive with organic produce, perhaps even displacing organic produce in health conscious marketing efforts. Our survey results indicate that these perceptions may have been premature. The market for produce is segmented, and will become increasingly so, so that various types of products can find niches in the larger food system.

As indicated in Table 4, twice as many chains carry organic products as carry 'pesticide free' produce. Furthermore, the stores that carry 'pesticide free' products also carry organics. Five chains responded to our questions concerning 'pesticide free' produce. Two of these chains have carried 'pesticide free' produce for six months or less, three for more than one year. The main reasons for carrying 'pesticide free' produce are that there is a niche market for it; that it protects against the risk of safety scares and the adverse associated publicity; and that it is necessary to meet the competition (Table 12). Interestingly, there was no perception that government residue testing was inadequate. Three of five chains reported being 'very satisfied' with private laboratory testing, but one reported being 'not satisfied,' and one did not respond. (The cost and performance of private certification laboratories are highly variable).

Demand prospects for this type of produce are uncertain. Of the eleven chains that do not now carry 'pesticide free' produce, only one plans to use a private certification program in the foreseeable future. Of the five chains currently using this facility, two expect to expand their usage, two do not. Thus, the prognosis for utilization of private testing is mixed--half of our respondents believe that it has peaked; one-quarter believe it is increasing, and one-quarter believe it is declining.

Table 12. Reasons Chains Carry Certified Pesticide-free Produce

	No. of chains
There is a niche market for it	3
Can't afford bad publicity if produce has residue above tolerance	2
Competitors carry it	2
Government residue testing is inadequate	0

Implications of supermarket performance and policy reforms for organic industry prospects

The results of this survey have positive implications for the organic food industry, but they must be viewed with caution. First, this was a survey of California supermarkets. We do not suggest that the results are generalizable to the larger U.S. market. The California market for organics is atypical. In fact, Cook (1991, p. 12) identifies the San Francisco Bay Area as "the nation's primary target market for products merchandised with food safety labels, especially organic." She attributes the relative success of organics in this market to "high concentrations of target consumers in a small area, a large pool of organic growers in surrounding counties with direct marketing links to Bay Area retailers and distributors, and the efforts of distributors to extend shipping seasons and improve supply consistency by encouraging production in several California regions and developing joint ventures with producers in Mexico" (Cook, 1991, p. 12).

The organic distribution system in California has been further facilitated by the ability of produce managers at the store level to make purchasing decisions about local organic produce. This reduces handling through central warehouses and enables produce to reach store shelves while it is still fresh and attractive. Still, many of our respondents perceived organics as worse than their conventional counterparts with respect to shelf life and appearance. The clear implication is that, when long distances and much post-harvest handling are involved, organics are likely to be less competitive. Some attribute at least part of the problem to the fact that post-harvest fungicides are prohibited in the post-harvest treatment of organically grown produce, soft fruits being particularly at risk in this regard. Yet the relatively successful marketing program for organics in Northern California's coastal region raises questions about what is critical to that success and their implications for other areas.

Until organic products are available at

much lower premiums over conventional products, they will appeal to specific consumer markets that place high value on their perceived attributes, which include: lower residues, positive impacts on the environment, and better nutritional value and flavor. Although a significant majority of U.S. consumers identify themselves as environmentally conscious, probably fewer are substantially motivated by environmental concerns at the point of purchase.

With the evolution of market survey research techniques--in particular, geographic information systems (GIS)--it has now become possible to identify consumers with specific clusters of demographic and psychographic characteristics by geographic location. San Francisco Bay Area consumers are unlikely to be unique. We need to identify the clusters of demographic and psychographic characteristics that appear to be conducive to organic marketing in this area and find similar clusters of reasonable sizes in other parts of the country. Focusing efforts in these areas would enhance marketing effectiveness.

Hall et al. (1989) argue that government policies related to the provision of market information to decision-makers would improve the performance of the organic marketing system. Labeling would be a key component of this information system. This would reduce consumer uncertainty and address consumer confusion over the meanings of labels such as "pesticide free," "IPM," and "organic" (Hall et al., 1989). Some states have no legal definitions for these terms. California has had a legal definition of organically produced foods since 1979, amended in 1982 and 1990. This may have enhanced marketing efforts in California while retarding it in states without a legal definition. (Of an estimated 5,328 organic growers in the U.S. as of 1989, 1200 to 1300 were estimated to be in California, more than one in five.) This will change, however, when the federal Organic Foods Production Act of 1990 becomes effective on October 1, 1993. All farms that produce food purported to be organic will then be required to be certified by an independent state or local certification agency. Certification agencies will be accredited by the USDA and will conduct annual on-site inspections. They may require periodic residue testing and can charge fees for their services.

Regarding proposals for increasing information to consumers and marketing decision-makers, Hall et al. (1989, p. 64) suggested that "...the costs are small, the costs are confined to limited time periods, and neither consumer choice nor producer choice is restricted." However, the costs of administration and compliance do not appear to be trivial. In fact, although the California legislature has been willing to legislate standards of production and labeling for organically produced foods, it has been considerably less willing to allocate resources for enforcement of those standards. Similar concerns are being raised about the federal regulations.

In addition, the costs of compliance are considerable. The information requirements for certification and enforcement of organic standards potentially are significant and may add to the cost of production of products that already are sold at substantial premiums. For example, the California law mandates a nonrefundable registration fee of from $25-$2000, depending on the volume of sales. In the first year of the program, an additional 50 percent is added to the fee to fund startup costs. Thus, providing information to consumers to ensure conformity with the legal definition of "organically produced" could affect the market in opposing ways. Theoretically, retailers' willingness to carry organic foods would increase with the reduced marketing risks from clear and meaningful labels and product identification. Consumers should be more willing to purchase organically produced products if they were more assured about organic claims because of stringent compliance with legal standards. The changed responses on the part of retailers and consumers would shift the demand curve for organics. On the other hand, compliance with more stringent and universal regulations increases the costs of production, wholesaling, and retailing. The result could be increased consumer prices, which, given the consumers' present willingness to pay, would reduce consumption. It is not possible to predict the net effect of the various supply and demand responses.

Finally, Hall et al. (1989) make two other proposals pertinent to supermarket performance in organic marketing: research to evaluate the effectiveness of alternative supermarket marketing strategies, and regular market news information on availability, prices, distributors, wholesalers, and producers.

Regarding the effectiveness of alternative supermarket marketing strategies we are unaware of any systematic research that has been carried out in the interim. Much anecdotal information has been provided to the mass media by food marketers, and the entry into and withdrawal from organic marketing has been used as a rough index of performance. (Waterfield, 1991; Zind, 1992) Cook (1991, p. 12), for example, asserts that "Developments have provided a 2-year experiment with organics through conventional supermarket channels. After the Alar publicity of February 1989, many U.S. retailers introduced organic sections, and several large-scale grower-shippers in California now produce organic products in large enough quantities to sell to chains. Organic distributors, too, have developed chain-store distribution programs. Yet national interest in organic produce that surged during the Alar publicity quickly subsided. National marketplace research has shown that many chains have eliminated their organic sections or reduced the number of stores handling organics due to weak sales and high shrink."

Thus, the inference has been drawn that consumers have decreased or withdrawn their interest in organics, which in turn explains organics' failure in supermarkets. But with respect to systematic examination of alternative marketing strategies for product, price, place and promotion--the so-called four P's of marketing--this proposed agenda remains unaddressed. Alternative hypotheses abound to explain the failure of organics in many supermarkets. "Produce managers don't know how to handle organics," "Organics are allocated a token amount of shelf space and hidden away in a corner of the produce section," "Retailers weren't serious about integrating organics into their business anyway,

was merely a public relations, marketing gimmick." But until researchers examine the performance of many markets and marketing channels, we will be forced to rely on anecdotal evidence of varying credibility.

Market news information for organics is still limited. The only source we know of is OMNIS, the Organic Market News and Information Service. Based in Colfax, California, OMNIS provides biweekly reports of prices received by growers, retail prices, and wholesale prices for organic and comparable nonorganic produce. Over 100 commodities are included in the OMNIS reports, which draw prices predominantly from California distributors. No surveys have been carried out to determine the level of usage of this market information.

Summary and conclusions

The media-fueled food safety episodes in the Spring of 1989 involving Alar and Chilean grapes created a surge of interest in and demand for organically grown produce. The organic food system had difficulty keeping pace with this increase in demand, bottlenecks developed, and prices increased sharply. When consumers later became less fearful of conventional produce, demand for organics diminished and several retail chains that had introduced organic lines lost interest in them and began dropping them. It appeared that the effect of the Alar and grape scares had boomeranged on organics.

Two surveys of chain store perceptions and practices in 1989 and 1990 suggest that organics have earned a niche in chain store produce marketing and that there is room for expansion and growth. Although they still are perceived by produce managers as disadvantageous compared to conventional produce, attitudes appear to be changing. Organics rate highly with respect to environmental impacts, chemical residues, flavor, and nutrition, but poorer in appearance and shelf life.

The favorable perceptions of key quality attributes offer opportunities for greater consumer acceptance, particularly if price premiums continue to decrease. Other keys to greater market penetration will be increased availability, a better coordinated collection and distribution system, more competitive prices, and targeted promotion. However, the recently passed federal Organic Foods Production Act of 1990 may retard the expansion of production. If this happens, organic products' penetration of the mainstream food marketing system will suffer.

References

1. Cook, R. L. 1991. An Overview of the Dynamic U.S. Fresh Produce Industry. In Adel A. Kader and F. Gordon Mitchell (eds.). Postharvest Technology of Horticultural Crops. University of California, Division of Agriculture and Natural Resources, Publication 3311.
2. Hall, D. C., B. P. Baker, J. Franco, and D. Jolly. 1989. Organic Food and Sustainable Agriculture. Contemporary Policy Issues 8(4):47-71.
3. La Ganga, M. L. 1990. Soaring Prices Slash Organic Produce. Fresno Bee, July 1.
4. Toufexis, A. 1989. Dining with Invisible Danger. Time, March 27. pp. 28-38.
5. Waterfield, L. 1991. Supermarket sales decrease. The Packer, September 14.
6. Zind, T. 1992. Organics market may never have existed. The Packer, January 25. p. 10A.

Industrialized World Moving to Sustainable Ag, Says Report

The trend in farming in the industrialized countries is toward adoption of environmentally beneficial practices, according to *World Resources 1992-1993*, a biannual report of conditions and trends in the global environment, published by the World Resources Institute, the United Nations Environment Programme, and the United Nations Development Programme.

"Some government policies are beginning to change as awareness of environmental degradation grows, giving farmers new incentives to adopt resource-conserving alternative practices," the report says. "A change in thinking also is underway. Policymakers only now are beginning to integrate the environmental costs of farming with its economic structure...

"What seems to be emerging is a synthesis based on both old, proven ideas and a new understanding of natural nutrient cycles and ecological relationships," the report concludes.

Within the "Food and Agriculture" chapter of the 385-page book is a 10-page "Focus on Agriculture in the Industrialized World: Toward Sustainability," which reviews the practices, history, and perspectives of alternative agriculture. The chapter also lists "problems with the conventional model" of agriculture, both on-farm and off-farm, and discusses agricultural policies that create "a new environment," including land conservation programs, management agreements to protect environmentally sensitive areas, tax incentives to encourage sustainable practices, and government subsidizing of the conversion to organic farming.

Among the report's recommendations for encouraging the transition to sustainable agriculture are removing price supports and other policy distortions; providing investment capital or otherwise reducing risks for farmers; returning the cost of off-site damages to the farm sector by imposing agrochemical taxes; providing tax incentives for sustainable practices; and paying farmers directly to adopt sustainable practices or retire land.

World Resources 1992-1993 is available for $19.95 plus $3 shipping and handling from WRI publications, P.O. Box 4852, Hampden Station, Baltimore, MD 21211.

The economics of small-scale rabbit production

Tesfa G. Gebremedhin

Abstract. *Diversification into alternative enterprises appears to be gaining in popularity and economic importance as a way to supplement family income and to provide alternative sources of high-quality food. However, potential rabbit producers lack information about investment requirements and production and marketing costs. The objective of this study was to determine the most profitable operation of small-scale rabbit production by estimating the costs and returns, net present values, and payback periods of two rabbit production systems. Despite a difference in the net income generated, a cash surplus occurred for both systems at the end of the third year. This surplus was the return to land, family labor, and management. Thus, rabbit enterprises may provide economic opportunities for farm families who have limited land and capital.*

Key words: rabbit production, alternative enterprises, economic potential, financial analysis

Introduction

Faced with more competitive markets for traditional commodities, new environmental regulations, and increasing production costs, U.S. farmers struggled to survive in the 1980s. This struggle has caused farmers to look for opportunities to integrate alternative enterprises into conventional farm operations. Alternative enterprises have great potential to provide alternative employment and income earning opportunities to farmers and rural communities; to develop new markets for domestic products; to develop new sources of inputs for industry and new products for consumers; to reduce agriculture's adverse effects on human health and the environment; to reduce the need for government intervention in agriculture; and to reduce risk and stabilize cash flow (Dicks, 1988).

A very critical challenge confronting small farmers today is to maintain adequate family income and decrease income variation by controlling risk. To do this, some farmers are diversifying their operations by including high value specialty crop or animal enterprises. Farmers with an abundant water supply may consider aquaculture alternatives, while others with limited resources might consider small supplemental enterprises including rabbits, goats, small fruits, and vegetables. Diversification into alternative enterprises appears to be gaining in popularity and economic importance as a way to boost family income and to provide alternative sources of high-quality food (Redfern et al., 1985).

Rabbits can be produced on small farms or in urban areas where the production of other livestock is impractical. As a part-time enterprise, rabbit production affords farm families and rural residents, suburban backyard entrepreneurs, youth, and the elderly an opportunity to use available family labor and a small amount of land. Less space, capital investment, and labor are needed to grow rabbits than for most other animals (U.S. Department of Agriculture, 1982). Rabbits can provide more meat from forage-based diets than any other type of livestock (French, 1982). One doe will produce about 25 to 50 rabbits a year. That is about 100 to 200 pounds of rabbits (liveweight) if they are raised to the four-pound size for frying (U.S. Department of Agriculture, 1982). One caged doe can produce 70 to 95 pounds of dressed meat per year, depending on the breed. No other animal can be kept in a space of about one square yard and annually produce eight to ten times its own body weight. Although this level of production could not be expected under small-scale conditions, it does reflect the rabbit's potential (Huss, 1985). Improvements in management could lead to increases in productivity by increasing the breeding rate, survival rate, litter size and sale weight, and by decreasing the mortality rate.

Rabbits can be raised in backyard production systems using farm-grown or locally produced feedstuffs (Food and Agriculture Organization, 1981). The required facilities are simple and can be constructed from locally available and scrap materials. The advantages of raising rabbits also include high reproductive rates, rapid growth, limited housing requirements, greater utilization of marginal land, ability to use fibrous plant material, crop residue and other agricultural by-products for foods, and ease of transportation to the market because of their small body size.

Consumers in the United States are becoming increasingly concerned about their diets. Current changes in food consumption patterns resulting from a desire for healthful foods have led to an increased demand for food without chemical additives and pesticides. Eating habits are changing in favor of low fat and low sodium meat. Rabbits produce all white meat that is low in fat, cholesterol, and sodium. Rabbit meat is a good

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source of protein, iron, and phosphorus. It is tender and easily digestible and is well-suited for persons on low-fat, low-sodium diets. Americans consume 20 to 30 million pounds of domestic rabbit meat each year, produced in small backyard units and large commercial rabbitries (Louisiana Cooperative Extension Service, 1978). Rabbits as a source of meat serve a useful function in meeting nutritional requirements for consumers. Low-income farm families and rural residents who are unable to produce other meat products may be able to improve their families' nutrition by raising rabbits.

In addition, rabbit production may have economic potential other than producing meat for the market and home consumption. An increasing demand for rabbits for educational and biological research purposes may offer marketing opportunities for breeders living near hospitals and research laboratories. Rabbits make excellent pets, and many are sold each year as "Easter Bunnies." In addition, they can be raised and bred for show purposes. Rabbit pelts and fur are used for garment manufacture. Rabbits also are excellent for 4-H Club, Future Farmers of America, and Boy and Girl Scout projects.

Currently, the rabbit industry, like many other specialty animal enterprises, is relatively small. Its profitability on a commercial scale is low compared to production of larger animals such as cattle and swine because of the high management requirements, high cost of feed, and disease problems (French, 1982). However, changes in food consumption patterns in the United States because of perceived health benefits may lead to an increase in the demand for rabbit meat.

An economic analysis is necessary to evaluate whether an investment in rabbit production will yield long-run profits. The main objective of this study is to determine the economic potential of rabbit production by estimating the investment requirements and production costs and returns of two production systems. The paper provides baseline information and direction for future development of rabbit enterprises. The study also has implications for alleviating the economic and health problems associated with poor nutrition in low-income rural and urban populations.

Procedure

Two alternative production systems for breeding rabbits were considered for economic analysis: (1) the breeding herd size was kept constant at 25 does and one buck (HS-25); (2) the breeding herd size was allowed to grow by 5 percent per year (HS-25/5%). A comparison of the payback periods (P) and net present values (NPV) and a financial feasibility analysis on borrowed funds were the methods used to determine the most profitable operation for meat rabbit production.

The payback procedure calculated the time it would take to recover the initial investment from the yearly income stream generated by the investment alternatives. The payback period was determined by dividing the initial cash outlay by the projected annual earnings obtained from investment. Investments that have a short payback period are more desirable.

The net present value method first projects gross cash income for each year. Second, the net annual cash flow is calculated as gross cash income minus cash expenses on an after-tax basis. Third, the present value of projected cash flow is computed as the sum of each year's discounted cash flow, using an appropriate discount rate. Fourth, the net present value is computed as the present value of the cash flow minus the initial investment value or cash outlay. This procedure reflects the time value of money and the opportunity cost of having funds tied up in capital items (Boehlje and Eidman, 1984).

The purpose of financial feasibility analysis also was to determine whether an investment would generate sufficient income to make the principal and interest payments on borrowed funds used to finance the initial investment requirements. It was assumed that the producer could take a three-year loan for the full initial cost, with three equal annual principal payments and 12 percent interest deductions on the outstanding balance. The tax savings from interest deductions were calculated as the interest payment times the marginal tax rate, which was assumed to be 21 percent.

The biological parameters used to calculate cost and returns for the two operations were obtained at the Southern University Rabbit Farm. Revenue and cost estimates were from survey data collected from the Louisiana Commercial Rabbit Growers Association (LCRGA), equipment retailers and feed dealers, and from secondary data (Table 1). Fixed costs were estimated for all capital requirements, such as breeding stocks, housing, cages, feeders, nest boxes, water supply systems, and veterinary supplies. Estimates of annual operating costs included feed, medical service and supplies, electricity, water, interest payments, and miscellaneous expenses. Estimates of annual gross sales of rabbits considered weaned fryers, culled does and doelings. The difference between the total estimated costs and estimated gross sales is an estimate of the annual average net revenue attributed to family labor and management used in the production process.

Results and discussion

The total initial investments for HS-25 and HS-25/5% were $1,966 and $2,529 respectively, as indicated in Table 2. The building amounted to 60 percent of the initial investment, and cages and breeding stocks accounted for about 29 percent. It was assumed that the building would be 10 feet wide with an aisle down the center and one row of cages on each side of the aisle and that each doe would be housed in a 30" x 30" x 18" cage (McNitt, 1986a). The remaining 11 percent was for water systems, nest boxes, feeders, miscellaneous cleaning equipment, and cage repairs. The actual costs would depend to a large extent on management. Yearly operating cost and sale prices of rabbits were assumed to increase by 3 percent per year because of inflation. The feed cost was estimated at $54 per doe, or 90 percent of the total yearly operating cost. Except for grass and vegetables, which rabbits forage on their own if allowed to do so, feed costs about $0.10/lb. It takes about four pounds of feed to grow each pound of a live fryer and to maintain its mother

Table 1. Basic Parameters Used for Estimating Costs and Returns, 1986

	Estimate	Constraints* % Change/Yr	Constraints* Limit
Biological Parameters			
Kindling (litter) rate	80%	1.5	96%
Kit survival rate	85%	1.0	96%
Fryer survival rate	84%	1.0	96%
Flock culling rate	8%		
Breeding rate	6/litter	1.5	10.45/litter
Roaster mortality rate	25%	−1.5	0.0%
Flock growth rate	5%		
Replacement survival rate	95%		
Fryer weight	4 lbs.	2.5	6 lbs.
Mean litter size	7.3	1.0	9.45
Revenue Estimates			
Fryer sale price per lb.	$0.60	3.0	$0.89
Culled doe price per lb.	$0.25	3.0	$0.35
Fixed Cost Parameters Per Doe			
Building at $3.00/sq. ft.	$60.00		
Cage (30″ × 30″ × 18″)	17.00		
Water system	4.00		
Nest box	2.50		
Feeder	3.00		
Breeding stock	11.50		
Miscellaneous	2.00		
Operating Cost Estimates Per Doe			
Feed	$54.00	3.0	$75.00
Utilities - electricity, water, etc.	3.00	3.0	4.00
Veterinary & animal health supplies	3.00	3.0	9.95

* The constraints mean that the estimates are assumed to change at the indicated rate per year until the limits are reached in ten years.
Sources: McNitt (1986 a, b).

Table 2. Projected Annual Cash Income and Cash Expense for Two Alternative Rabbit Production Systems*

Year	HS-25 Cash Income	HS-25 Cash Expense	HS-25/5% Cash Income	HS-25/5% Cash Expense
1	$1335	$1500	$1335	$1500
2	1572	1543	1650	1657
3	1850	1587	2040	1786
4	2090	1632	2420	1926
5	2343	1679	2848	2083
6	2626	1727	3351	2247
7	2904	1777	3892	2426
8	3255	1828	4580	2620
9	3608	1880	5331	2826
10	4067	1934	6309	3055

* The initial investment requirements or cash outlays for HS-25 and HS-25/5% investment alternatives are $1,966 and $2,529, respectively.

(U.S. Department of Agriculture, 1982). Utilities (including electricity and water) and veterinary and animal health supplies were each estimated at $3 per doe and accounted for 10 percent of overall operating cost.

Initial investment requirements, average annual revenues, payback periods (P), and net present values (NPV) for the two production alternatives are shown in Tables 2 and 3. The net present values for the two alternative investments are calculated for 10 years at different rates of return. The payback periods for HS-25 and HS-25/5% are 1.40 and 1.72 years, respectively. Thus, on this basis, HS-25 is preferred to HS-25/5% (Table 3). The net present value criterion gave the reverse ordering from the payback periods criterion. A comparison was also made to a third scenario in which the breeding herd size was kept constant at 50 does and two bucks. The estimated costs and returns were twice those of HS-25, but the payback periods were the same.

Table 3. Payback Periods and Present Values of Ten Year Net Cash Flows of Two Rabbit Production Systems

Criterion	HS-25	HS-25/5%
Payback (P)	1.40 years	1.72 years
Discount Rate*	Net Present Value (NPV)	
i = 0.00	6,597	9,115
i = 0.04	4,339	6,131
i = 0.06	3,477	4,780
i = 0.08	2,752	3,780
i = 0.10	2,137	2,935
i = 0.12	1,616	2,224

* Discount rate is used to reflect the time value of money by adjusting future flows of income back to the present value.

Based on the financial feasibility analysis, cash deficits occur in the first three years for both HS-25 and HS-25/5% (Tables 4 and 5). Until the debt is paid off, returns over cost will be small. Thereafter, cash surpluses, attributed to land, family labor, and management occur for the remaining life of both investment alternatives. Even if net return is positive at the end of the third year, the cash surpluses may not be sufficient to cover family and owner-operator labor and management at minimum wage rates. However, based on the economic analysis, HS-25/5% may be more profitable than the other alternative. But HS-25/5% may not be financially feasible if its initial investment requirement ($2,529) compared to what is required by HS-25 ($1,966) is considered to be large. Thus, HS-25 would be the preferred alternative production practice for the small-scale producer with limited finances and resources.

Table 4. Financial Feasibility of Initial Cost Outlay, HS-25

Year	Annual Net Cash Flow	Payment Schedule[1]			Tax Savings from Interest Deductibility[2]	After-Tax Payment Schedule	Annual Surplus or Deficit ()
		Principal	Interest	Total			
1	$(165)	$656	$236	$892	$50	$842	$(1,007)
2	29	655	157	812	33	779	(750)
3	263	655	79	734	17	717	(454)
4	458	—	—	—	—	—	458
5	664	—	—	—	—	—	664
6	899	—	—	—	—	—	899
7	1,127	—	—	—	—	—	1,127
8	1,427	—	—	—	—	—	1,427
9	1,728	—	—	—	—	—	1,728
10	2,133	—	—	—	—	—	2,133

[1] It was assumed that the operator would take a three-year loan for the full initial cost outlay of $1,966 with three equal principal payments and 12% interest on the outstanding balance.
[2] The tax savings from interest deductibility was calculated as the interest payment times the marginal tax bracket (assumed to be 21%).

Table 5. Financial Feasibility of Initial Cost Outlay, HS-25/5%

Year	Annual Net Cash Flow	Payment Schedule[1]			Tax Savings from Interest Deductibility[2]	After-Tax Payment Schedule	Annual Surplus or Deficit ()
		Principal	Interest	Total			
1	($165)	$843	$303	$1,146	$64	$1,082	($1,247)
2	7	843	202	1,045	42	1,033	(996)
3	254	843	101	944	21	923	(629)
4	494	—	—	—	—	—	494
5	765	—	—	—	—	—	765
6	1,104	—	—	—	—	—	1,104
7	1,466	—	—	—	—	—	1,466
8	1,960	—	—	—	—	—	1,960
9	2,505	—	—	—	—	—	2,505
10	3,254	—	—	—	—	—	3,254

[1] It was assumed that the operator would take a three-year loan for the full initial cost outlay of $2,529 with three equal principal payments and 12% interest on the outstanding balance.
[2] The tax savings from interest deductibility were also calculated as the interest payment times the marginal tax bracket (assumed to be 21%) in an after-tax payment schedule.

Conclusion

The economic and financial data analyses indicate that rabbit production will allow small-scale producers to generate supplementary family income. Economic returns for two alternatives covered the initial investment costs before the beginning of the second year if the business is equity financed. The enterprise generates a cash surplus to the producer at the end of the third year of operation if the business is financed with borrowed funds. With greater production experience and improved management skills, rabbit production could be a profitable alternative agricultural enterprise. Foundation stock, housing, feeding, breeding, and sanitation are critical for a successful rabbit operation. At present, rabbit farming is not a common practice on U.S. farms. Even though rabbit production is making some contribution to the national meat supply, the industry has received very little attention from policymakers, planners, and agricultural scientists. Perhaps the search for health foods and the current economic situation of the farm sector will make rabbit production a more important industry.

A stable, progressive rabbit production for small-scale producers earning an adequate return on investment will require an expanded market. Coordinated efforts are needed at the state, regional, and national levels. U.S. Department of Agriculture market promotion programs and a national educational campaign may help to enhance rabbit production and marketing. Home economists could be a vital component of this campaign. Rural schools, through 4-H Clubs and Future Farmers of America, could also be used for introducing students to the production and consumption of rabbits. Incentives such as the establishment of a strong association of rabbit growers and the development of meat processing facilities are needed to encourage small-scale producers to consider rabbit production as an alternative enterprise and to facilitate promotional market programs. Federal and state governments and land grant universities need to undertake research and extension programs that provide rabbit producers with adequate production and marketing information to help them plan and develop their operations.

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References

1. Boehlje, M. D., and V. D. Eidman. 1984. Farm Management. John Wiley & Sons, New York, New York.
2. Dicks, M. R., and D. Harvey. 1988. Aquaculture Situation and Outlook. AS-4, Mississippi State University, Mississippi.
3. Food and Agriculture Organization (FAO). 1981. Report of the FAO Expert Consultation on Rural Poultry and Rabbit Production. AGA-805. FAO/UN, Rome, Italy.
4. French, F. M. 1982. Small Animal Enterprises for Small Farms. USDA, Agricultural Economics Report No. 1422, Washington, DC. pp. 178-183.
5. Huss, D. L. 1985. Small animals for small farms in Latin America and the Caribbean. In F. H. Baker and M. E. Miller (eds.). Emerging Technology and Management for Ruminants. Winrock International, Westview Press, Inc., Boulder, Colorado.
6. Louisiana Cooperative Extension Service. 1978. Raising Rabbits. Cooperative Extension Publication No. 1608. Louisiana State University, Baton Rouge, Louisiana.
7. McNitt, J. I. 1986a. Economics of commercial meat rabbit production. Missouri Farm 3(2):12-13.
8. McNitt, J. I. 1986b. The Use of a Simulation Program for Rabbit Herd Projection. Center for Small Farm Research, Southern University, Baton Rouge, Louisiana.
9. Redfern, J. M., J. A. Yazman, A. Z. Deboer, P. J. Haward, and M. D. Norman. 1985. The Goat Milk Industry of Northern Arkansas and Southern Missouri. Winrock International, Morrilton, Arkansas.
10. U.S. Department of Agriculture. 1982. Getting Started in Farming on a Small Scale. Agricultural Information Bulletin No. 451. Office of Governmental and Public Affairs.

COMMENTARY

Assessing the character of agricultural production systems: Issues and implications

Sandra S. Batie and Daniel B. Taylor

Abstract. *Alternative agriculture can be viewed as an alternative belief system to that underlying conventional agriculture. However, alternative agriculture can also be viewed from a technological perspective—that is, as a set of substitute technologies to conventional agriculture from which a farmer can selectively choose. Definitional distinctions between low-input, organic, sustainable, and conventional agriculture become important with this second perspective. Different policy and research implications are generated from these competing perspectives.*

Key words: Alternative agriculture; research; public policies

Alternative agriculture systems are frequently offered as a superior choice to conventional agricultural systems to achieve some or all of the objectives of farmers, government, and society. These objectives include:

- profits
- production
- agricultural employment
- quality of life
- environmental quality
- habitat or species protection
- ownership patterns and rural community vitality
- regional self-sufficiency
- democracy and individual freedom
- trade patterns
- human health, and
- equitable distribution of economic returns.

Some authors offer alternative agriculture as a holistic belief system that should replace the belief system underlying conventional agriculture (Beus et al., 1991). Others offer alternative agriculture as a set of substitute technologies to those of conventional agriculture from which a farmer (or society)--regardless of his or her beliefs--can select to achieve these objectives (Beus et al., 1991). Different policy and research implications stem from these differing perspectives.

Alternative agriculture as a belief system

Alternative agriculture as a belief system involves a holistic philosophy, and it incorporates alternative values to those of conventional agriculture: family and group self-reliance, harmony with nature, a global village view of the world, a respect for nature and ecosystems, a voluntary simplicity, the goal of sustainable economic development, and a belief in the "goodness" of the family farm (Dahlberg, 1985).

This holistic philosophy leads to a definition of alternative agriculture as an agriculture that is "economically viable, ecologically sound, socially just and humane" (Luna, 1988). While having historical roots (Beus et al., 1991), this concept of alternative agriculture is founded on a vision of the future: "a vision of what could be if we choose a different set of objectives; a vision of agriculture" that nurtures both the land and the people (Luna, 1988). This perspective of alternative agriculture puts limited faith in technological progress, views humans as part of a nature that is to be valued for its own sake, and emphasizes community cooperation as well as non-materialistic lifestyles (Beus et al., 1991). In contrast, conventional agriculture is underlain by a belief system that has faith in technological progress, that tends to view nature as consisting of resources that are available and valuable for human use, and that emphasizes individualistic competition and materialism (Beus et al. 1991). With this perspective, conventional agriculture and alternative agriculture are not merely a set of different choices; they embody different points of view about the role of pesticides in food production, homegrown produce, lifestyles, and small farms (Libby, 1985).

There are many terms used in describing alternative agriculture, such as sustainable agriculture, regenerative agriculture, low-input agriculture, organic

Parts of this paper have drawn on Batie and Taylor (1989; 1990a; 1990b) and Taylor (1990).

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agriculture, or eco-agriculture. The differences between these terms are not critical when they are perceived as sharing a common underlying philosophy (Lockeretz, 1986). All these terms can be viewed as "non-conventional" agriculture and as an alternative "way-of-thinking." What is critical is that the dichotomy between conventional and alternative agriculture serves as a proxy for the dichotomy between a reductionist-science-based, chemical-intensive agriculture and that of a holistic-science based on community- and environment-enhancing agriculture (Batie and Taylor, 1989). It is not until one contemplates alternative agriculture from a technological perspective that definitional distinctions rise in importance.

Alternative agriculture from a technological perspective

It is not necessary to embrace an alternative, holistic belief system to adopt alternative agriculture practices. Indeed, within the United States, there has been substantial adoption of alternative practices and systems that appear to have been motivated mainly by the desire to reduce production costs. For example, the adoption of many integrated pest management (IPM) practices appears to have occurred because these practices improve the efficacy of pesticide applications and reduce the farmer's input costs. In essence, the farmers are selecting some alternative technologies from a set of conventional and alternative technological options. Adoption of total systems of non-conventional practices underlain by strong philosophical orientations and ecological principles is probably far less common. (The argument can be marshalled, however, that if farmers switch to non-conventional agriculture for transient reasons, such as low crop prices, then such a conversion will also be transient and any benefits of conversion will be short-lived [Lockeretz, 1990].)

Thus, alternative agriculture can be perceived as an alternative set of technologies to those of conventional agriculture. In this context, distinguishing between terms has more relevance. The importance of definitional distinctions within this perspective can be explored via the use of Figure 1. In Figure 1, a 1992 view of agricultural production is depicted by the four circles in a Venn diagram representing conventional, low-

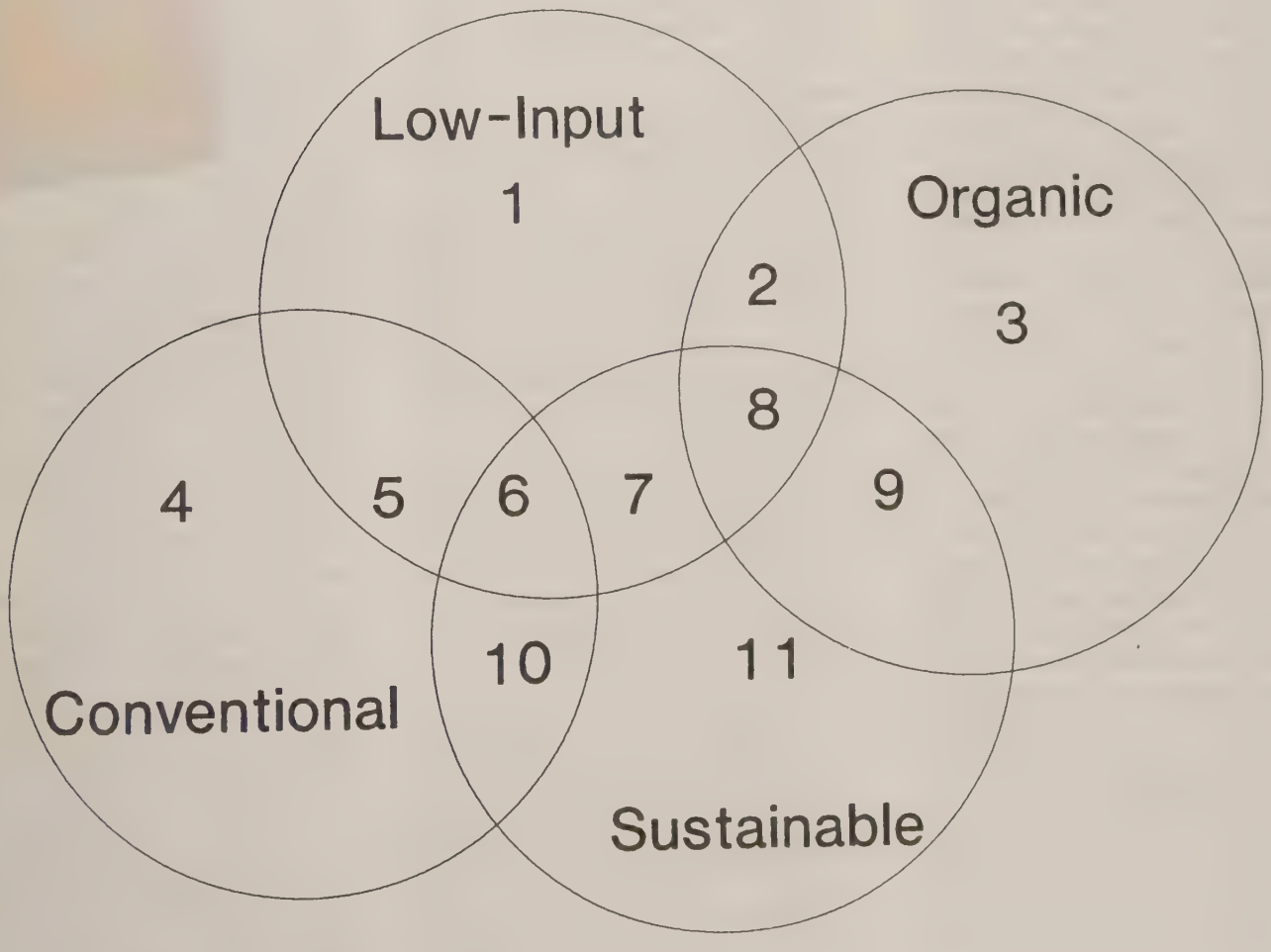


Figure 1. Views of Agricultural Production - 1992

input, organic, and sustainable agricultural practices. Conventional agriculture can be thought of as those practices currently employed by the majority of farmers. These methods employ an intensively mechanized production system that is dependent on high levels of synthetic pesticides and nutrients. Low-input agriculture consists of those practices that have reduced use of these synthetic and usually petrochemically based inputs relative to conventional practices. Organic production is defined as using no synthetic pesticides or nutrients. Sustainable production suggests a method of production that can continue indefinitely.

The area of the diagram labeled 4 suggests that, currently, some conventional production systems are high-input and not sustainable. Few would argue with this assertion, especially in light of current environmental and health concerns associated with conventional production. Yet in some producing regions, IPM is the conventional practice. Some IPM practices can thus be considered both low-input and conventional, as represented by Area 5. Some IPM practices, particularly those that rely on biological indicators to predict the impact of crop pests, may be the conventional practices in an area and may also be sustainable, as represented by Area 6.

Low-input systems, such as many of those being developed by the United States Department of Agriculture's Low-Input Sustainable Agriculture (LISA) Program, represented by Area 1, are generally neither conventional production systems nor organic systems. Their development is focusing on the reduction but not necessarily the elimination of synthetic pesticides and nutrients. An example is splitting a fertilizer application into two or more applications, with the rate of each application based on tissue and soil tests. Another example is spraying low levels of herbicides adjacent to the plant rows while mowing or cultivating between the rows.

An example of an organic practice might be the use of animal manures or green manures to replace commercial fertilizers. If animal manures are used on appropriate soils and managed carefully, such practices may be organic, low-input, and sustainable (Area 8). However, it is not difficult to imagine situations where such use more appropriately would be assigned as low-input and organic but not necessarily sustainable (Area 2). Such would be the case where manures are applied excessively or inappropriately or where the quantity of manure is so much lower than the quantity needed that organic production cannot continue indefinitely. However, organic production need not be low-input from the standpoint of the quantity of "natural" pesticides and nutrients. In fact, organic production can be very high-input with respect to fuel and labor (Area 3).

Sustainable production, also often referred to as regenerative agriculture, thus becomes complicated to define. It includes practices such as the IPM example that are currently labeled as conventional, represented by Area 6 in Figure 1. Such sustainable practices may require higher-input systems and be generally thought of as conventional (Area 10, Figure 1). Surely, many tillage systems such as tillage on the contour and strip-cropping could be so classified. Sustainable production can include other low-input practices (Area 7 in Figure 1) such as crop rotations and either low- or high-input organic practices (Areas 8 and 9, respectively). Area 8, as discussed, could include animal manure practices; production systems in Area 9 could use labor and mechanical cultivation in place of herbicides. Finally, practices that are sustainable but not part of organic, low-input, or conventional agriculture (Area 11) might be those of wilderness foraging such as the harvest of wild rice or wild mushrooms.

Alternative agriculture can then be defined as any practice or system not in the conventional set. Choosing to use these practices or systems may or may not be motivated by the acceptance of non-conventional philosophies.

The classifications encompassed by these definitions are not static; they change over time. For example, consider two systems of production: the "slash and burn" agriculture of the tropics and "pastoral nomadism" practices in more arid regions. Both systems, which evolved over thousands of years, at one time were in balance with the environment of their areas and would have been viewed as sustainable. However, changing situations, such as population increases and the establishment of national boundaries, have led to a shortening of the rotation period for both "slash and burn" and "pastoral nomadism." The result has been that, in most, if not all, regions of the world, these systems no longer are sustainable, yet they are still being employed. For additional examples of the dynamic nature of these definitions, consider that IPM and conservation tillage, such as no-tillage, were once considered as alternative agriculture practices but are now generally accepted as conventional agriculture practices in many parts of the country. (Whether IPM is an alternative or a conventional practice was debated in this journal [Crosson, 1989; Madden, 1989].)

Implications

Whether one views alternative agriculture as just another type of technology in a smorgasbord of technologies or as embodying an alternative belief system will influence perceptions of both research and policy. For example, until recently agricultural research has been almost exclusively directed toward improvement of conventional systems. Only recently have there been some mainstream investigations into the other sets of systems, as represented in Figure 1. A research objective now appears to be the expansion of the intersection of the conventional set with that of the low-input or sustainable set. For those who believe conventional agriculture must be supplanted by sustainable systems founded on alternative belief systems, the expansion of the conventional system with research conducted by "conventional" researchers holds little promise (Lockeretz, 1990). Yet this new interest in and funding of alternative agricultural research is applauded by those who focus on the ultimate impact of the adoption of alternative technologies on desired goals, such as improved environmental quality.

Furthermore, how public policies should be changed to achieve sustainability goals differs according to whether one perceives alternative agriculture as a belief system or as a set of

technologies. If the goal is, say, environmental quality protection independent of belief systems or technological choices, then there are many possible policy changes. These include targeting public policies to specific goals, such as environmental quality protection. Such targeting would replace the current policy of asking one policy instrument to achieve many, sometimes competing, policy goals. Furthermore, if the goal is environmental quality protection, then policies can be directed not so much at obtaining low-input or sustainable agricultural systems as such, but rather at achieving improved environmental quality. These goals can be achieved by practicing a "high information agriculture"- that is, capitalizing on existing knowledge with respect to the "linkages" of agricultural practices to environmental quality. For example, many argue for the use of manures instead of commercial fertilizers as both a low-input and an organic production practice. But use of manures on certain soils can exacerbate both ground water and surface water pollution problems and sometimes exceed the leaching of commercial fertilizers (Diebel, 1990). Thus, low-input and organic agriculture does not necessarily equal improved environmental quality, any more than conventional agricultural technologies necessarily equal degraded environmental quality. Careful selection of practices based on "linkages" information can therefore achieve more environmental protection than requiring farmers to select from only one type of agricultural technologies, such as conventional or low-input agricultural practices.

With the alternative-agriculture-as-technology perception, the achievement of environmental quality goals depends on practicing a high information agriculture that incorporates knowledge about soil type, topography, farm practices, and the pollution potential and financial impacts of practices, to minimize pollution problems in an economically viable manner. Research and extension products could alert farmers and policymakers to the ultimate impact of alternative agricultural systems and practices on short-run and long-run environmental quality or other objectives. A high information-driven agriculture would also include research and extension products that better incorporate a systems approach and that recognize the limitations of reductionist science for the obtainment of social objectives.

In contrast, if the goal is the widescale incorporation of new ethics and beliefs about the use of natural resources, substantially different actions are required. Incorporating new ethics into mainstream policies and thinking is not impossible, but it takes considerable time and education efforts, starting with kindergarten and including the mass media. We have seen considerable activity in this regard in U.S. educational systems and in the mass media, but we suspect we are a generation away from determining its ultimate impact on changed lifestyles. Also, a research and extension agenda accompanies the desire for broader acceptance of an alternative belief system. Such an agenda includes analysis of changing public values and the reflection of changed values in policy and action. The time necessary for discerning significant changes in values as reflected in action can be quite lengthy, however. In the meantime, we anticipate more incorporation of environmental quality and other objectives into public policies. One avenue offered to meet these objectives will be alternative agriculture.

References

1. Batie, S. S., and D. B. Taylor. 1989. Widespread adoption of non-conventional agriculture: Profitability and impacts. American Journal of Alternative Agriculture 4:128-134.
2. Batie, S. S., and D. B. Taylor. 1990a. Sustainable agriculture, alternative agriculture, and the college curriculum. Staff Paper 90-27, Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. October 11.
3. Batie, S. S., and D. B. Taylor. 1990b. Sustainable agriculture and U.S. policy. Staff paper 90-28, Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia. November 8.
4. Beus, C. E., R. E. Dunlap, R. M. Jimmerson, and W. L. Holmes. 1991. Competing Paradigms: The Debate Between Alternative and Conventional Agriculture. Research Bulletin XB1020, College of Agriculture and Home Economics, Research Center, Washington State University, Pullman, Washington.
5. Crosson, P. 1989. What is alternative agriculture? American Journal of Alternative Agriculture 4:28-32.
6. Dahlberg, K. A. 1985. Ethics, values, and goals in agricultural systems and agricultural research. In T. C. Edens, C. Fridgen, and S. L. Battenfield (eds.). Sustainable Agriculture and Integrated Farming Systems: 1984 Conference Proceedings. Michigan State University, East Lansing, Michigan. pp. 202-218.
7. Diebel, P. L. 1990. An economic analysis of low-input agriculture as a groundwater protection strategy. Unpublished Ph.D. dissertation. Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
8. Libby, L. 1985. Summary: Economics. In T. C. Edens, C. Fridgen, and S. L. Battenfield (eds.). Sustainable Agriculture and Integrated Farming Systems: 1984 Conference Proceedings. Michigan State University Press, East Lansing, Michigan. pp. 117-120.
9. Lockeretz, W. 1986. Alternative Agriculture. In K. A. Dahlberg (ed.). New Directions for Agriculture and Agricultural Research. Rowman and Allanheld, Totowa, New Jersey. pp. 291-311.
10. Lockeretz, W. 1990. Major issues confronting sustainable agriculture. In C. A. Francis, C. B. Flora, and L. D. King (eds.). Sustainable Agriculture in Temperate Zones. John Wiley and Sons, New York, New York. pp. 432-438.
11. Luna, J. 1988. Defining sustainable agriculture. Paper presented at the 2nd Annual Virginia Conference on Sustainable Agriculture, Harrisonburg, Virginia. March 5.
12. Madden, P. L. 1989. What is alternative agriculture? American Journal of Alternative Agriculture 4:32-33.
13. Taylor, D. B. 1990. Economics of sustainable agriculture: A search for sustainability and profitability. Staff Paper 90-8. Department of Agricultural Economics, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

LETTERS TO THE EDITOR INVITED

The AJAA welcomes letters, short or long, commenting on articles in this journal or sharing ideas likely to be of interest to other AJAA readers. Since our space is limited, we do reserve the right not to publish all letters or, at times, to publish only excerpts from them. To take part in this exchange of ideas, write to: Editor, AJAA, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

Plant Diseases: Their Biology and Social Impact. 1991. By Gail L. Schumann. American Phytopathological Society, St. Paul, Minnesota. 397 pp. $45.00, hardbound.

This book is a fascinating treatment of the science of plant pathology. Plant pathology encompasses many disciplines, ranging from classical taxonomy of plants and microorganisms to the leading edge of modern molecular biology. The goal of this book is to explore plant pathology as a biological science with ties to human welfare. This is achieved in part by presenting the history of plant diseases and famines and their impact on human food supplies. Considerable use is made of current approaches to understand various aspects of science and biotechnology.

The idea of this book came from a course that the author taught at the University of Massachusetts as part of the general education curriculum. The book is therefore very readable from a general science standpoint. Although used for teaching purposes, the book is aimed at a general audience concerned with legislation governing environmental protection, pesticide use, release of genetically engineered organisms, land preservation for agricultural use, and preservation of genetic reserves.

The book is technical in that almost all aspects of plant pathology are covered in enough detail to give an accurate but concise treatment of the entire discipline. However, it is written in a "friendly" manner that can be understood by a non-plant pathologist. Even readers without a scientific background should obtain an appreciation of plant pathology and its concerns with world food supplies and the environment. Technical words are used appropriately, are clearly defined in the text, and can be referred to in an inclusive glossary of technical terms provided at the end of the book. Each chapter is briefly referenced for those interested in pursuing subjects in greater detail. The index allows easy reference to specific subjects in the text. The text is excellently illustrated with archival and modern photographs of many diseases, agricultural practices, and personalities. Also used as illustrations are political cartoons, diagrams of pathogen life cycles, photomicrographs of pathogens, as well as examples of modern methods of scientific discovery and disease control. The illustrations bring to life a text already written in a lively, interesting manner.

The rationale for the sequence of chapters is not always fully clear. Nevertheless, Chapter One begins, appropriately, with the birth of the modern science of plant pathology sparked by the Irish potato famine in 1845. This famine brought about the recognition that microorganisms cause plant diseases and that important food supplies can be destroyed by these unseen infectious agents. There also is discussion of the dangers of monocropping and the need for genetic diversity. The prospects of the destruction of food staples is still possible today, with the world's food supply strongly dependent on a few major crops, such as potatoes, corn, wheat, and rice.

Subsequent chapters integrate historical disease epidemics and the basic biological life cycles of the microorganisms with social changes. Examples given include the impacts of coffee rust, leaf blight of rubber, Panama disease of bananas, fire blight of apples, and the devastation of forests and urban plantings in the U.S. by chestnut blight and Dutch elm disease. Each of these major epidemics emphasizes the importance of federal and state quarantines to prevent or contain the introduction of new organisms from foreign sources into vulnerable plant populations. The reverse phenomenon is also possible, illustrated by three major problems that almost destroyed European grape production in the 19th century: powdery mildew, phylloxera, and downy mildew, all native to North America, and imported accidentally into Europe. Grafting of rootstocks and introduction of chemical pesticides solved the problems and ushered in a new era of chemical pesticide control of plant diseases.

Chapter Six on plant disease epidemics and their management places the "epidemic pyramid" at the center of understanding the concept. This symbol of disease, familiar to all plant pathologists, has time as an important factor in the development of epidemics, which are composed of susceptible plants, virulent pathogens, and a favorable environment. This chapter sets the stage for the subsequent chapter on pesticides. The author emphasizes the importance of chemical pesticides as a component of disease control systems and discusses the cost/benefit factors involved. Although the need for fungicides is recognized, their reduced usage as part of integrated pest management (IPM) systems is stressed. IPM and sustainable agricultural concepts are indicated as important components of future disease control strategies. The discussion includes the need for federal and state regulation of disease control chemicals and other strategies, such as biological control measures, to assure safe and effective usage of materials that potentially are harmful to the environment. Chapter Eight treats biological control in the context of the soil environment, including the plant rhizosphere and soilborne pathogens. Biological control is emphasized in this chapter because of increased interest in it for control of soilborne pathogens and because of problems with ground water contamination by pesticides.

An interesting chapter on fungi in food goes somewhat beyond the confines of plant pathology to discuss oc-

currence of natural poisons and carcinogens produced by fungi that may contaminate foods. It also covers fungi that may themselves be edible, or even gourmet delights. Disease caused by nonbiological factors is treated in a chapter on "Environmental Diseases and Problems." The final chapter, "Plant Diseases in a Hungry World," concludes the book in a similar vein to the beginning chapter, in which the Irish potato famine introduced the subject of plant diseases to the world. In this chapter Dr. Schumann points out the possibility of future worldwide famines brought on by plant pathogens. Of the 800,000 species of plants in the world, only 3000 are edible. Of these, only 150 are commonly eaten, only 12 contribute significantly to the food supply, and only three account for most of the world's caloric consumption. These limited crops are vulnerable to epidemics and other vagaries of agriculture, including limited arable land under constant erosion, limited water resources, and soil fertility problems. Also discussed are the need for genetic diversity in agriculture to reduce the chances of devastating losses; preservation of gene pools of existing plants to provide more and varied food crops in the future; and genetic modification for improving existing crops and allaying epidemics.

Plant pathologists are working to reduce vulnerability of crops to plant diseases on a world scale. This is enhanced by increased availability of technological improvements through computers, new immunoassay techniques for detection and quarantine of diseases, constant selection of disease resistant cultivars, and dramatic advances in biotechnology. Dr. Schumann concludes by stating "The political, social, economic, and ecological choices that humans make in the next decade will have far-reaching effects on the earth's environment. These decisions will determine whether life becomes more uncertain in an increasingly inhospitable environment or whether we can find an ecological niche that will provide a reliable and sustainable quality of life for the human population as well as for other members of our ecosystem. The science of plant pathology will continue to play a critical role in this quest." -- *Robert D. Lumsden, Research Leader, Biocontrol of Plant Diseases Laboratory, Beltsville Agricultural Research Center, U.S. Department of Agriculture, Beltsville, MD.*

Biotechnics and Society: The Rise of Industrial Genetics. 1991. By Sheldon Krimsky. Praeger, New York, Westport, Connecticut and London. 229 pp., notes, selected bibliography, and index. $17.95, paper; $47.95, cloth.

No one is as well-positioned as Sheldon Krimsky to provide us with a broad and yet satisfyingly detailed review of the "questions being asked," the "options available," and the "decisions being made" in the "infancy" of the industrial application of genetic technologies. This book is quite readable by a fairly general audience. Occasionally the style shifts to a more detailed and exacting account than the average reader might wish, though I found such precision gratifying. Though the book's scope is already large, I was disappointed that there was no chapter devoted to the role of "gentechnics" in biological weapons development.

The first chapter, on "The Cultural Significance of the Genetics Revolution," piques the reader's interest as the author examines the symbolic meanings of gentechnics: the cell as a machine or factory, life forms as products of manufacture, and genes as causal factors for human conditions and behaviors. In it Krimsky raises the question that informs the rest of the book: How can "industrial America, through its experience with the atomic age, hazardous chemicals, ecological degradation, and occupational hazards, draw upon the collective wisdom of largely well-intentioned people and guide biotechnology through a path safer than that of previous technological revolutions of a similar transforming character?" The author does not answer this question, but provides information, tools, and analysis to assist the reader.

The book is a series of essays, each of which could stand on its own, organized thematically into three parts. In "Part I: The Industrial Context," three chapters succinctly describe the brief, sometimes dazzling, history of the biotechnology industry thus far, the history and controversy surrounding the patenting of life forms, and the increasing integration of academic biology into the industry.

"Part II: Genetics and Ecology," begins provocatively by placing environmental applications of gentechnics in the historical context of the "Baconian legacy," that to know nature is to manipulate it for human ends. Krimsky notes that previous "efforts to control and harness nature...had resulted in mixed outcomes." However, it is left to the reader to interpret this legacy, as the rest of the chapter describes but doesn't evaluate the range of potential environmental applications.

Chapter six describes and analyzes the evolution of regulatory policy from laboratory research to field applications. This chapter is followed by a detailed political and regulatory history of ice minus, an application of gentechnics to the prevention of frost damage to crops. Students and advocates of biotechnology regulation will find an excellent reference in the meticulous accounts of policy development in these and other chapters.

The final chapter in Part II usefully abstracts from the ice minus case history to analyze the disparity of views between the two major groups of scientists involved in evaluating environmental risks: ecologists and molecular geneticists. This chapter provides a very clear and cogent description of the major philosophical issues separating these communities. Krimsky really is at his best when he is describing and analyzing the issues at stake in a particular controversy.

"Part III: Social Controls," concludes the book with three chapters addressing the social governance of biotechnology. The first deals with efforts to define under what conditions human genetic engineering is ethical and should be allowed or disallowed, and who should decide. Krimsky lays out

the range of opinions and the history of debate and raises important questions but does not explicitly offer his own conclusions.

In the next chapter, Krimsky addresses the need for and the development of a coherent apparatus to regulate environmental releases. This is a very useful history, and I only wished that it could have been brought more fully up to date with the important interventions by the White House Council on Competitiveness that recently have threatened to undermine the development of reasonable regulations.

The final chapter was for me the most useful in adding something new to our ability to analyze and make social choices about the issues raised in the rest of the book. Krimsky asserts (though unfortunately doesn't justify) five premises for the social governance of biotechnology and then develops a useful framework for technology assessment that includes dimensions he has identified in previous chapters as missing from the policy tool kit: ethical soundness, distributive justice, and social need. These factors are added to the more readily accounted for ecological impacts, health effects, economic productivity, and market demand. This framework is applied to three imminent applications of gentechnics: bovine growth hormone, herbicide tolerant plants, and human growth hormone.

This scheme makes an important contribution to our ability to evaluate the many dimensions of a new technological application. A tighter link between the historical and analytical essays and the argument of the last chapter could have strengthened the argument, although the questions raised in the earlier essays do prepare the reader to some extent. And I would have liked to see a more thorough discussion of how this assessment framework might be utilized. For example, how should the factors be weighted when they contradict each other? How could such factors enter into social governance through the law? And how should "ethical soundness," "distributive justice," and "social need" be defined and measured? Krimsky gives hints, but I would have found it helpful had he made his own positions on these issues more explicit.

This is a very useful and thought-provoking book with a great deal of insight and information. It would be an excellent choice for "science, technology, and society" courses, for example; and it is useful for other (bio)technology analysts as well. I remain mildly unsatisfied at having to surmise the author's own conclusions and opinions on the important questions he raises. It seems to be his respect for the "collective wisdom" that makes him more the recorder, interpreter, and heuristic provider than the advocate. However, I would have preferred that he more actively contribute to the *construction* of that collective wisdom. If it is to be collective, we all have to throw our hats in the ring. -- *Elizabeth Ann R. Bird, Research Policy Analyst, Center for Rural Affairs, Walthill, NE.*

Dryland Agriculture: Strategies for Sustainability. 1990. Edited by R.P. Singh, J.F. Parr, and B.A. Stewart. Advances in Soil Science, Vol. 13. Springer-Verlag, New York.

This book follows the series' tradition of serving the international agriculture community. Leading scientists with international experience and expertise analyze and summarize available research information on dryland agriculture and delineate important principles. The book's objectives, as stated in the first chapter, are 'not only to address the current state of the art, including research needs and priorities, but also to present new perspectives and strategies to minimize the risks of dryland farming.' The selection of topics reflects these objectives. A strength of the book is that the objectives of each chapter are clearly defined and the means used to achieve them clearly documented.

Sustainability of dryland agriculture is extremely important, because arid and semiarid regions have some 700 million inhabitants and cover about 40% of the world's land area, 60% of which is in developing countries. Increasingly, the food required to meet projected population increases in India and the Near East will have to come from dryland agriculture. The book discusses production restrictions imposed by the resource base, and the factors that threaten its sustainability. Increased production in many dryland areas is severely constrained by soils that are fragile, inherently low in fertility, organic matter and water-holding capacity, and susceptible to wind and water erosion.

Because of the overriding importance of water in dryland agriculture, five of 17 articles deal primarily with agroclimatology or water use related to agricultural production. One discusses agricultural productivity in semiarid tropics, a second analyzes farm management practices in the Sahel, and a third describes the use of crop simulation models in Australia and central Texas. Four chapters are devoted to tillage and crop residue management, including one on crop residues in crop/livestock systems and another on the effects of residue management on soil organic matter. The importance of soil and water conservation in dryland agriculture is stressed repeatedly, with two chapters dealing with control of wind and water erosion. Other topics covered include: plant diseases, methods to overcome spatial variability in research studies, and nutrient cycling. A final summary chapter is concerned with strategies for increasing the productivity and stability of dryland farming systems.

Sustainability, especially long term maintenance of soil productivity, is incorporated throughout the individual chapters, and is an underlying principle in the discussions of production. Topics relevant to this theme include: soil conservation, water quality, management of soil organic matter and nutrients, tillage and management of crop residues. There also is an economic analysis of farm management practices for a specific region, the Sahel.

An inescapable conclusion from these discussions is that relationships among soils, crops, and climate must be considered carefully to correctly apply and evaluate production practices that will be sustainable. A second conclu-

sion is that there are serious constraints on increasing agricultural production in arid and semiarid agriculture while adequately protecting the soil resource. Clearly, the potential for increased production exists, but a great deal of work is needed to achieve it while insuring agricultural sustainability for several of the world's arid and semiarid regions.

The basic principles discussed in the book are important to agriculture in general, not just dryland production in regions of low rainfall. Chapters on case studies and crop simulation models illustrate how information on climate, soils, and crops can be used to evaluate production alternatives in arid and semiarid areas; these methods also can be applied to areas with more favorable rainfall. Although the book was written for the international agriculture community, it will be of interest to a much wider group, including people in academic institutions and agencies involved in planning agricultural development and environmental protection. It also will serve as a valuable reference for research and graduate teaching not only in the specific topics covered, but also in the broader areas of international agricultural development and agricultural sustainability.—*James Swan, Professor, Department of Agronomy, Iowa State University, Ames*

BOOK NOTICE

Food from Dryland Gardens: An Ecological, Nutritional and Social Approach to Small-Scale Household Food Production. 1992. David A. Cleveland and Daniela Soleri. Center for People, Food and Environment, Tucson, AZ. xiv + 387 pp. $25, soft cover.

Both as a beginner's guide as well as a reference for those with more experience, this book is written for field workers, extension agents, students, project workers, and program planners in the Third World, as well as gardeners in the industrial world interested in sustainable dryland food production. It covers understanding existing gardens as the basis for improvements; using low-cost local resources to promote self-reliance; scientific principles of garden management; improving household nutritional status and income; and ecological sustainability, including the conservation of soil, water, and genetic resources.

ECONOMISTS JOIN BIOCONTROL RESEARCH

Economists have usually not participated in biological control research projects, whose advantages have seldom been proclaimed except by biocontrol researchers. With funding from the LISA program, a project coordinated by researchers and economists at the University of Florida hopes to strengthen the "weak link" between extension and biocontrol research by including economic analysis in biocontrol research. The project will supply current and future biocontrol information to extension specialists throughout the Southern Region by means of a computerized data base. Information which extension specialists will be able to obtain directly from the data base by computer-modem link will be in a form usable to them, and will include economic analyses to be derived from existing published and unpublished data by economists. The project also seeks to use partial budgeting to analyze the economics of classical biocontrol research being developed in the Southern Region, and to keep the computerized data base updated and available throughout the Southern Region. For more information, contact J. Howard Frank, Project Coordinator, Entomology & Nematology Department, University of Florida, Gainesville, FL; (904) 392-1901, ext. 128.

IOWA AG-ENERGY PROGRAM WINS EPA AWARD

The Iowa Agricultural-Energy-Environmental Initiative has received one of 17 prestigious EPA Administrator's Pollution Prevention Awards, selected from 840 programs nationwide. The Ag-Energy Initiative is the umbrella for various statewide, coordinated inter-agency efforts, including the Big Spring Basin Demonstration Project, the Integrated Farm Management Demonstration Project, and the Model Farms Projects. The award was presented to the Department of Natural Resources, which coordinates the Ag-Energy Initiative.

PROPOSAL WOULD LET FARMERS DRAIN WETLANDS

The USDA is considering a plan that would allow farmers to drain millions of acres of wetlands from the Mississippi Delta to the prairie potholes of the Great Plains. Under the 1990 Farm Bill, producers who drain wetlands are barred from receiving federal farm subsidies unless they meet certain conditions indicating they acted in good faith. The current USDA proposal says wetlands that had been farmed six out of ten years would be considered "prior converted croplands," which means they are not subject to the law forbidding drainage or other alterations. According to Senator Patrick J. Leahy (D-VT), the USDA's own estimates indicate that the exemptions could destroy 10 million acres of wetlands, including 58% of the wetlands in the prairie pothole region of the Dakotas and the upper Midwest, as well as extensive areas of farmed wetlands in the lower Mississippi Valley.

Organic Farming Symposium computer disks of 41 papers given in January are available for $10. Indicate IBM or Macintosh version; make check out to UC Regents. Send to Small Farm Center, University of California, Davis, CA 95616; (916) 757-8742.

Soil Management: The Key to Sustained Fertility, a video, is available from Sustainable Agriculture Research and Education Program, University of California, Davis, CA 95616.

Chemical Vs. Ecological Lawn Care, an annotated bibliography, is available for $1 plus a stamped, self-addressed envelope, from Ecological Agriculture Projects, Box 191, Macdonald Campus, Ste-Anne de Bellevue, QC, Canada H9X 1C0; (514) 398-7771.

"Farmer-to-Farmer: Strategies for Sustainable Agriculture" is a series of six half-hour videos produced with the Rodale Institute: Field Crops, Rotational Grazing, Vegetables, IPM for Vegetables & Small Fruits, IPM for Apples, and High-Value Marketing. Each is $29.95; the whole set is $149.95. Contact: Farm Videos, Rooy Media, 7407 Hilltop Drive, Frederick, MD 21702; (301) 473-8797.

"Resources for Sustainable Agriculture and Alternative Enterprises," a directory for Eastern Oklahoma and Western Arkansas, is available from Heidi Carter or Lara Ervin, Kerr Center for Sustainable Agriculture, P.O. Box 588, Poteau, OK 74953; (918) 647-9123.

"Alternative Agriculture: Research and Education," a 20-page report describing programs at Purdue University's Center for Alternative Agricultural Systems, is available free from the Center, Purdue University, 1145 Krannert Bldg., Room 649, West Lafayette, IN 47907-1145; (317) 494-4244.

"Farm Bill 1990 Revisited," an assessment of the Farm Bill, is available for $10 plus $3 handling from: Center for Resource Economics, 1718 Connecticut Ave., NW, #300, Washington, D.C. 20009; (202) 667-6982.

"Crops & Man," a 284-page book, is available for $34 from Soil Science Society of America, American Society of Agronomy Headquarters, ATTN: Book Order Dept., 677 South Segoe Road, Madison, WI 53711-1086.

"Never-Registered Pesticides: Rejected Toxics Join the 'Circle of Poison" is available for $5 from Greenpeace, 1436 U St., NW, Washington, D.C. 20009; (202) 462-1177.

"What the Farmer Needs to Know: A Summary of California and Federal Organic Production Laws," a 22-page booklet, is available for $5.95 plus $1.75 postage and handling from Suzanne Vaupel, Committee for Sustainable Agriculture Legislative Publications, 5864 13th St., Sacramento, CA 95822.

"Healthy Harvest," a global directory of sustainable agriculture and horticulture organizations, is $19.95 plus $3 shipping, from agAccess, 603 Fourth St., Davis, CA 95616; (916) 756-7177.

Soil and Plant Analysis Registry, information about 200 U.S. and Canadian laboratories, is available for $15 from Council on Soil Testing and Plant Analysis, Georgia University Station, P.O. Box 2007, Athens, GA 30612.

"Agriculture and the Environment" and **"Integrated Pest Management/ Biological Control: Natural Enemies,"** two fact sheets and bibliographies, are available from Alternative Farming Systems Information Center, National Agricultural Library, 10301 Baltimore Blvd., Beltsville, MD 20705 (301) 504-6559.

Pesticide Use: A Tale of Two Farms

Researchers are studying two side-by-side, privately owned and operated farms in Sciota, IL, which have the same soil, weather, and crops -- but one is pesticide-free. Researchers are comparing insect populations, soil structure, plant diseases, weeds, and crop yields to determine the effects of long-term pesticide use. The USDA is funding the research and analyzing some soil samples, and a University of Illinois plant pathologist will study fungi and diseases. Though it may take three or four more years to find the answers to all the researchers' questions, some preliminary results are available.

Richard Anderson, a biological scientist from Western Illinois University in Macomb, began his part of the work after 1991 corn planting, collecting insects from the soil and from light-traps in both treated and untreated fields. The farmer who used pesticides eliminated virtually all insects, while his pesticide-free neighbor has "tremendous numbers" of bugs -- some who ate corn, and others who ate bugs who eat corn. "There were plenty of corn rootworms and other agricultural pests, but a fair number of predators -- spiders and bugs that feed on other insects," he said. "There were earthworms, which are important in aerating the soil. Pesticide treatment eliminates them all."

IAA Board Elects President's Council for 1992

Jim Bender, IAA President, has announced the members of the President's Council for 1992. Members are: Dr. Jill S. Auburn, University of California, Davis; Dr. Charles Benbrook, Dickerson, MD; Norman A. Berg, Soil & Water Conservation Society; Bob Bergland, National Rural Electric Cooperative Association; U.S. Rep. George E. Brown, Jr., of California; Ron Ellermeier, farmer from Glenvil, NE; Dr. John C. Gordon, Yale University School of Forestry and Environmental Studies; Robert Gray, Resource Management Consultants, Inc.; Ralph Grossi, American Farmland Trust; Dr. R. Jim Hildreth, Oak Brook, IL; Mrs. Dana Jackson, Allston, MA; Dr. Dennis R. Keeney, Leopold Center, Iowa State University; Dr. Fred Kirschenmann, Kirschenmann Family Farms, Windsor, N.D.; U.S. Senator Patrick J. Leahy; Dan Martin, MacArthur Foundation; Dr. Ned S. Raun, Winrock International; Ronald L. Rosmann, farmer from Harlan, IA; R. Neil Sampson, American Forestry Association; Edward Sills, Pleasant Grove Farms, California; Dr. Karl N. Stauber, Northwest Area Foundation; Dr. David G. Topel, Iowa State University; and Dr. Stephen Viederman, Jessie Smith Noyes Foundation.

The Council was formed two years ago to provide guidance and support for Institute activities in promoting a more sustainable agricultural system in the United States and abroad.

Rosmann Publishes Column in Newsweek

"The path we're following continues to dry up small- and medium-size family farms and the small towns and community values that go along with them," wrote Ronald L. Rosmann, a member of the IAA President's Council, in the "My Turn" column of *Newsweek* on May 4.

The column, entitled, "This Land Is Your Land," calls for a sustainable agriculture system that ensures long-term food safety and availability, sustains a large number of farms and farmers, and supports strong, vibrant rural communities.

"Farm programs, initiated in the 1930s to help small farmers, have, over time, resulted in a major portion of the program going to large-scale agribusinesses. This encourages environmentally damaging practices on fragile lands," wrote Rosmann, a grain and livestock farmer in Harlan, Iowa.

Rosmann argues against three common agricultural myths: that bigger is better, that "one third of the world would starve if pesticides were eliminated," and that food prices would rise significantly if producer prices increase.

"Growing food, living in communion with the land and nature, raising livestock, guiding our children, having something to call our own -- all these things give life meaning," he wrote in conclusion. "I believe there is still a bit of farmer in all of us and that, given the choice, many would try this way of life. If we fail to see this and continue to move toward the corporate form of agriculture, the loss will be everyone's."

DeWitt Receives Practical Farmers Award

Jerald R. De Witt, director of agriculture for the Iowa Cooperative Extension Service and former IAA President, has received the Sustainable Agriculture Achievement Award from the Practical Farmers of Iowa. The award, presented to someone who has advanced the development of sustainable agriculture, honored the work DeWitt has done to "bring farmers and researchers together to work for profitable, environmentally sound farming."

Hinkle Named to National Research Council Committee

Maureen Hinkle, Director of the Agriculture Program at the National Audubon Society and member of the IAA Board, has been named to the National Research Council's Pest and Pathogen Control Through Management of Biological Control Agents and Enhanced Natural Cycles and Processes Committee. The committee is charged to assess the opportunities to accelerate the use of natural/biological pest and pathogen control systems in agricultural production. This study will address biological/natural control in the context of North America, Canada, the United States, and Mexico.

IAA Requests Increase in Sustainable Ag Funding

The IAA has asked Congress for a substantial increase in federal funding for sustainable agriculture research and education in fiscal year 1993. In a letter to Rep. Jamie Whitten, Chairman of the House Appropriations Subcommittee on Rural Development, Agriculture and Related Agencies, IAA Associate Director Neill Schaller wrote that the IAA was "spurred by a genuine fear that sustainable agriculture research and education programs authorized in the 1985 and 1990 farm bills are destined to fail if funded at levels proposed by the current Administration." He requested $25 million for the LISA program, which has been funded with just $6.725 million --

despite a $40 million authorization in the 1990 farm bill.

The IAA also requested $20 million for the National Training Program for Cooperative Extensive Service agents. "It is time to recognize, without apology or finger pointing, that our highly productive agriculture has unanticipated side effects that cannot be corrected by fine-tuning conventional practices," Schaller wrote. "Farmers desperately need, and want, reliable information on sustainable practices."

Hinkle, Kirschenmann Named to NRI Advisory Committee

Maureen Hinkle, Director of the Agriculture Program at the National Audubon Society and member of the IAA Board, and Fred Kirschenmann, of Kirschenmann Family Farms and member of the IAA President's Council, have been named to the Science and Education National Research Initiative (NRI) Advisory Committee. The committee, formerly called the Science and Education Competitive Research Grants Office Advisory Committee, will advise the Secretary of Agriculture about areas of research to be supported and priorities to be adopted and emphasized under the National Research Initiative; program progress and resource allocations; and ways to improve guidelines, evaluation and accomplishment reporting procedures. The committee will meet twice a year for two years.

Weiskel Most Recent IAA Visiting Scholar

Timothy C. Weiskel was the IAA's Visiting Scholar during March and April, doing research on the public policy implications of the relationship between the General Agreement on Tariffs and Trade (GATT), the environment, and the sustainability of agriculture in this country and abroad. Weiskel is from Harvard University, where he is a Research Fellow at the Pacific Basin Research Center of the Kennedy School of Government's Center for Science and International Affairs. He is also the director of the newly created Harvard Seminar on Environmental Values, based at the Harvard Divinity School. While at the IAA, he met in the Washington, D.C., area with agricultural and environmental activists, administration officials and Congressional leaders to learn more about the current Uruguay Round of the GATT negotiations, and their implications for agriculture and the environment.

The True Cost of Food: Proceedings of IAA Symposium Available

The proceedings of the IAA's Eighth Annual Scientific Symposium, "Understanding the True Cost of Food: Considerations for a Sustainable Food System," are now available. Copies of the 88-page soft-cover booklet are available for $ each from the IAA, 9200 Edmonston Road, #117, Greenbelt, MD 20770 (301) 441-8777.

Farm profiles invited

For its new department on alternative agriculture profiles, the AJAA welcomes short articles describing farmers who have adopted interesting alternative practices. The articles should include five elements: a brief description of the farm; the problems that made the farmer look for an alternative approach and the reasons why the alternative seemed plausible; a summary of the basic principles behind the alternative (possibly in a sidebar if it interrupts the flow of text); a discussion of how well the alternative has worked; and a discussion of the applicability of the alternative for other farms. The length should be 1500 to 2000 words.

Submissions must be accompanied by a release, signed by the farmer, giving permission for this material to be published in the *American Journal of Alternative Agriculture*. Vol. 3, No. 4, of the AJAA has a further description of the department (page 188); or query the editor for further information. Send submissions to the Editor, AJAA, 9200 Edmonston Road, Suite 117, Greenbelt, MD 20770.

GAO Report Substantiates Concerns About Pesticide Standards

A U.S. Government Accounting Office (GAO) report substantiates concerns about the potential impact on food safety of negotiations to eliminate agricultural trade barriers through the General Agreement on Tariffs and Trade (GATT). It describes the differences between U.S. standards for food safety and health, and international standards, especially those known as Codex. "As long as differences persist, the potential for restrictions on exports and imports and greater consumer exposure to pesticide residues will remain," according to the report. The report, "International Food Safety," #GAO/PMED-91-22, is available for free from GAO, P.O. Box 6015, Gaithersburg, Maryland 20877; (202) 275-6241.

UPCOMING EVENTS

August 1, Small Farm -- Sustainable Ag Field Day, sponsored by the University of Maine Cooperative Extension, Maine Agricultural Experiment Station, and Maine Organic Farmers and Gardeners Association, will be held in Old Town, ME. Contact: Rick Kersbergen, Waldo County Extension Office, (207) 342-5971.

August 4, On-Farm Composting Conference will be held at Penn State Harrisburg Campus, Middletown. **August 5**, a tour of on-farm composting operations in Lancaster County will be held. For both events, contact: Penn State Cooperative Extension, 191 Franklin Farms Lane, Chambersbrug, PA 17201; (717) 263-9226.

August 17 is the deadline for abstracts for a conference on agricultural research to protect water quality, sponsored by the Soil and Water Conservation Society, on February 21-24, 1993, in Minneapolis, MN. Contact: SWCS, 7515 Northeast Ankeny Road, Ankeny, IA 50211-9764.

August 21-30, Permaculture Design Workshop, taught by Dan Hemenway, will be held in West Olive, MI. Contact: David VanDyke, 15580 Stanton, West Olive, MI 49460; (616) 847-0560.

September 11, "Train the Trainers Workshop," sponsored by Rodale Institute, Practical Farmers of Iowa, and Iowa State University, will be held at the Thompson Farm, Boone, IA. Contact: Barbara Bruno, Rodale Institute, 222 Main St., Emmaus, PA 18098; (215) 683-6383.

September 19, New Jersey Organic Country Fair will be held at the Watershed Reserve in Pennington. Contact: Natural Organic Farmers Association of New Jersey, (609) 737-6848.

September 23-25, "Children, Youth and Families," the Twelfth Annual National Rural Families Conference, will be held at Kansas State University, Manhattan, KS. Contact: Conference, 141 College Court Cuilbind, Kansas State University, Manhattan, KS 66506-6015; (913) 532-5569 or 1-800-432-8222.

September 25-27, Common Ground Country Fair, sponsored by Maine Organic Farmers and Gardeners Association, will be held at Windsor Fairgrounds, Windsor, ME. Contact the Association at (207) 623-5115.

October 6-9, "Biobased Products Expo '92," sponsored by the U.S. Departments of Agriculture, Energy, and Commerce, and the New Uses Council, will be held in St. Louis, MO. Contact: Agricultural Research Institute, 9650 Rockville Pike, Bethesda, MD 20814-3998; (301) 530-7122.

New Sustainable Agriculture Coalition Forms in Illinois

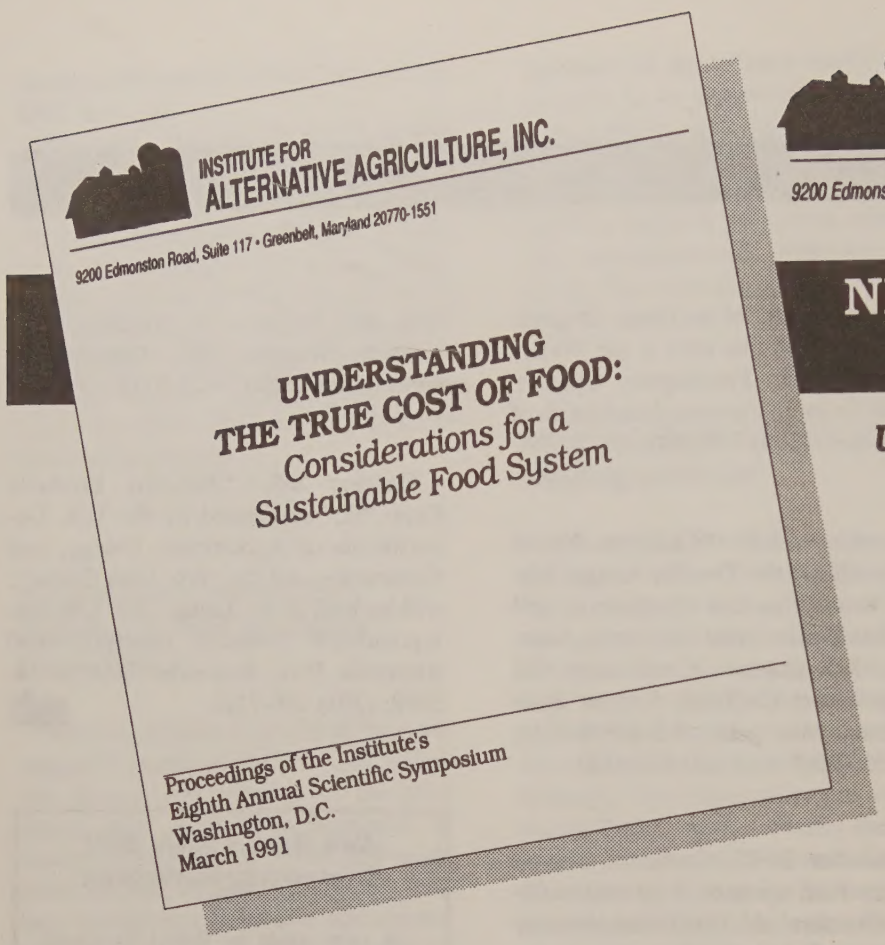
The Illinois Sustainable Agriculture Network has recently been formed as a cooperative effort of the Illinois Stewardship Alliance, Illinois Sustainable Agriculture Society, Southeastern Illinois Sustainable Agriculture Association, and University of Illinois, College of Agriculture. The network will conduct scientifically valid on-farm participatory research, and sponsor education projects such as on-farm demonstrations, farm tours, workshops, publications, regional meetings, and a farmer-to-farmer communication network. For more information, contact Deborah Cavanaugh-Grant, On-Farm Research and Education Coordinator, ISAN, P.O. Box 648, Rochester, IL 62563; (217) 498-9705.

New Report Fuels BGH Controversy in Vermont

A new study by Rural Vermont, which reported cows have been harmed by injections of bovine growth hormone (BGH or BST), has fueled the BGH controversy in Vermont and prompted the state's Congressional delegation to request more information about BGH from the U.S. Food and Drug Administration.

The report, based on previously secret data from the University of Vermont/Monsanto test herd, reveals that cows injected with BGH become ill, give birth to dead and deformed calves, and are sold for beef because of shortened milking lives far more frequently than other cows. The University has an agreement with Monsanto not to release these data until next summer; the information was given to Rural Vermont by confidential university sources.

BGH is the synthetic version of a hormone naturally occurring in cows, which increases milk production when given in higher than natural doses.



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Guide for authors

The American Journal of Alternative Agriculture (AJAA) publishes original research on biological, physical, or social science aspects of alternative agriculture. We particularly welcome multi-disciplinary studies, but papers from a specific discipline also are invited. However, since AJAA readership is much broader than for a single-discipline journal, highly specialized terminology should be explained or avoided. The significance of a statement, or the reasoning behind a conclusion, may have to be spelled out more than in a more specialized journal. See Vol. 5, No. 1, pp 2 & 3, for an explanation of the various categories of articles.

Units

Research papers should use the International (SI, or metric) system throughout. Occasional use of common unit equivalents in parentheses is permitted, mainly for relatively exotic SI units.

Title page

The title page should give the following information (all flush left): 1) title of the paper; 2) names of authors; 3) affiliation and office address of authors, and 4) acknowledgements, if any. See examples in this issue of AJAA.

Abstract

The abstract should be 200 to 400 words suitable for readers from a broad range of disciplines. It should avoid highly-specialized terminology that might be appropriate for a single discipline journal. Take particular care that the significance of the work is made clear, even to readers from a different field.

Key words

Provide subject matter key words suitable for use in scientific indexing.

Reference list

When citing material that has been covered in more than one format, such as the typescript of a conference presentation and a journal article, preference should be given to the version that is most readily available, and that is likely to remain so. Generally this means standard publication channels, such as books, journals, and regular government report series. Unpublished or informally-published material should be cited only when no alternative form exists.

References should be listed in alphabetical order by author's name, and by year for a particular author (with letters after the year if needed). If a sole author is also the lead author of papers with multiple authors, use the following order: single author (by year); two authors (alphabetically by second author's name); three or more authors (by year). Repeat the author's name for each reference. Use initials only for first and middle names. Give the names of all authors in the reference; never use "et al."

Use full names of journals, institutions, conferences, etc., except for extremely familiar abbreviations like "Dept." Remember that an abbreviation familiar to you may not be familiar to readers outside your field. If in doubt, write it out.

The reference list uses no quotation marks, italics, boldface, or underlining. Only the names of books and periodicals are in initial capitals. Names of papers, book chapters, pamphlets, and bulletins are not capitalized. Page numbers are written out in full (e.g., 1108-1123, not 1108-23). The volume is given if page numbers begin at 1 for each issue.

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Cite references in the text by last name and year, with chapter or page numbers if the reference is a book or lengthy report. For two authors, give both names. Do not use "et al." unless there are at least three authors.

Footnotes

AJAA does not use bibliographic or substantive footnotes. All bibliographic references should be at the end of the text. Instead of substantive footnotes, include the material in the main text or consider eliminating it.

Manuscript preparation

The entire manuscript, including abstract and references, should be typed on one side of standard-size paper, double spaced, with margins of at least one inch all around. Starting with the title page, label all pages in the upper righthand corner with the lead author's last name and the page number. Do not use hyphens unless the hyphen is part of the word.

Follow the section headings style used in this AJAA issue. All headings are flush left, with no underlining or italics.

Tables should fit on one page, be numbered consecutively with Arabic numerals, and be on a separate sheet. Leave extra space to separate columns. Every figure and table should be mentioned at least once in the text.

Submission of manuscripts

Submit four high-quality copies to Editor, American Journal of Alternative Agriculture, Suite 117, 9200 Edmonston Road, Greenbelt, MD 20770. The cover letter should state that the manuscript is an original contribution that has not been published elsewhere in substantially the same form; that it is not currently under consideration elsewhere, and that permission has been obtained for any copyrighted material used.

How you can help support the scientific and educational needs of a sustainable agricultural system

A growing number of Americans have become concerned about the long-term sustainability of our food production system. Farmers and agricultural scientists are among those raising questions about the growing dependence of modern farming on nonrenewable resources, the depletion of our resource base through soil erosion, and heavy reliance on chemical fertilizers and pesticides. Continued heavy reliance on farm chemicals is questioned because they have become an expensive production input. Their widespread use also raises questions about human and animal health, food quality and safety, environmental quality, and the continued demise of the family farm.

Low-input alternative farming methods address these economic and environmental challenges. Alternative production systems point the way toward more profits, more individual choice, and long-term sustainability for our food system. More must be done to develop effective ways to make sure research, education, and information sources are readily available to farmers who want to adopt these techniques.

The Institute for Alternative Agriculture needs your help in meeting this challenge. We are a nonprofit tax-exempt research and education organization set up in 1983 to encourage and facilitate the adoption of low cost, resource conserving, and environmentally sound farming methods. We work directly with government agencies, colleges and universities, producer groups, and other institutions that provide research, education and information services to farmers.

The Institute also provides these services:

- *A resource to lawmakers and others who influence agricultural research, education, and information policy*
- *A voice for alternative agriculture in Washington*
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